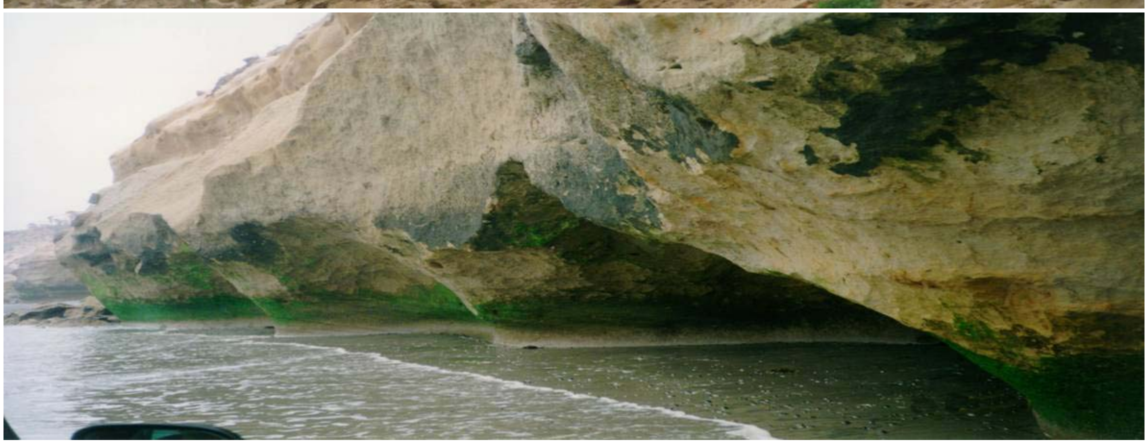
Encinitas and Solana Beach Shoreline Feasibility Study
San Diego County, California
Draft Feasibility Report



U.S. Army Corps of Engineers - Los Angeles District

August 2005

ENCINITAS AND SOLANA BEACH SHORELINE
DRAFT FEASIBILITY STUDY

Los Angeles District
South Pacific Division

Executive Summary

Introduction

The Solana Beach-Encinitas shoreline study area is located along the Pacific Ocean in the Cities of Solana Beach and Encinitas, San Diego County, California as shown on **Figure ES-1**. Encinitas is approximately 16 kilometers (10 miles) south of Oceanside Harbor, and 27 kilometers (17 miles) north of Point La Jolla. The Encinitas shoreline is about 9.6 kilometers (6 miles) long. It is bounded on the north by Batiquitos Lagoon and on the south by San Elijo Lagoon. The 1,500-meter-long (4,920 feet) southernmost segment of the Encinitas shoreline is a low-lying barrier spit fronting the San Elijo tidal lagoon.

Immediately south of Encinitas is the City of Solana Beach. Solana Beach is bounded by San Elijo Lagoon to the north and by the City of Del Mar on the south. It is approximately 27 kilometers (17 miles) south of Oceanside Harbor, and 16 kilometers (10 miles) north of Point La Jolla. Solana Beach's shoreline is about 3.2 kilometers (2 miles) long. Nearly all of the shoreline in the study area except Cardiff (Reach 7) consists of narrow sand and cobble beaches fronting nearshore bluffs.

The study area was divided into nine reaches (see **Figure ES-2**), and five of those reaches were found to have sufficient historic and projected damages for federal project justification. These five reaches were grouped into two Segments geographically. Segment One consists of Reaches 3, 4, and 5 of the Encinitas Shoreline and Segment Two consists of Reaches 8 and 9 along the Solana Beach shoreline.

Background

Before the 1970s, beaches in the study area were generally wide enough to provide protection to the coastal bluffs, and the shoreline was more stable. However, loss of littoral sediment supplied historically by rivers has resulted in severely depleted beaches in most of Southern California. Since the beach was lost, the annualized rate of marine erosion of the coastal bluffs has at least doubled in Encinitas, and has increased an order of magnitude in most of Solana Beach, prompting property owners to install seawalls and other protective structures. The California Coastal Commission (the state permitting agency created to implement the California Coastal Act) has historically been very resistant to granting permanent seawall permits, but is legally compelled to grant emergency permits when a structure is in imminent danger of collapse from wave attack and/or undermining.

Segment One – Encinitas

The shoreline section between the 700 block of Neptune Ave. and Swami's (Reaches 3, 4, and 5) is approximately 3.2 kilometers long. This segment includes one park, Moonlight State Beach, and five public access points; Encinitas Beach County Park, Seaside Gardens Park, Moonlight State Beach, and H St. and I St. Viewpoint parks/access. Most of the narrow, sandy beach in Segment One is backed by sandstone bluffs that support about 160 residential properties. The bluff top ranges in height from approximately 10 meters (30 feet), adjacent to Moonlight Beach, to approximately 25 to 30 meters (80 to 100 feet). Along most of Segment One there is a 2 to 8-foot notch formed at the base of the bluff where storm waves erode the bluff toe, undermining the land above. In 2000, a sudden bluff collapse in the Segment killed a woman sitting too close to an overhanging section.

Segment Two - Solana

Segment Two (Reaches 8 and 9) comprises the entire shoreline within the boundaries of Solana Beach (**Figure ES-2**), and is approximately 2.3 kilometers in length. It includes one public park, Fletcher Cove Beach Park; and three public access points including Tide Beach Park, Fletcher Cove Beach Park, and North Seascape Surf Beach Park.

The shoreline within this reach can be characterized as a narrow to non-existent sandy beach backed by high, steep sea cliffs. The bluff top ranges in height from approximately 15 to 25 meters (47 to 80 feet), and is fully developed with single family homes, multiple family town homes and condominiums, comprising about 85 separate parcels. Along most of Segment Two there are notches and some sea caves formed at the base of the bluff where storm waves erode the bluff toe, undermining the land above. The developed notches range in depth from approximately 0.7 to 2.6 meters (2 to 8 feet). Seacaves, several of which extend as deep as 6 to 10 meters (18 to 30 feet), are present in several areas near the southern portion of Segment Two.

FIGURE ES-1 – STUDY AREA

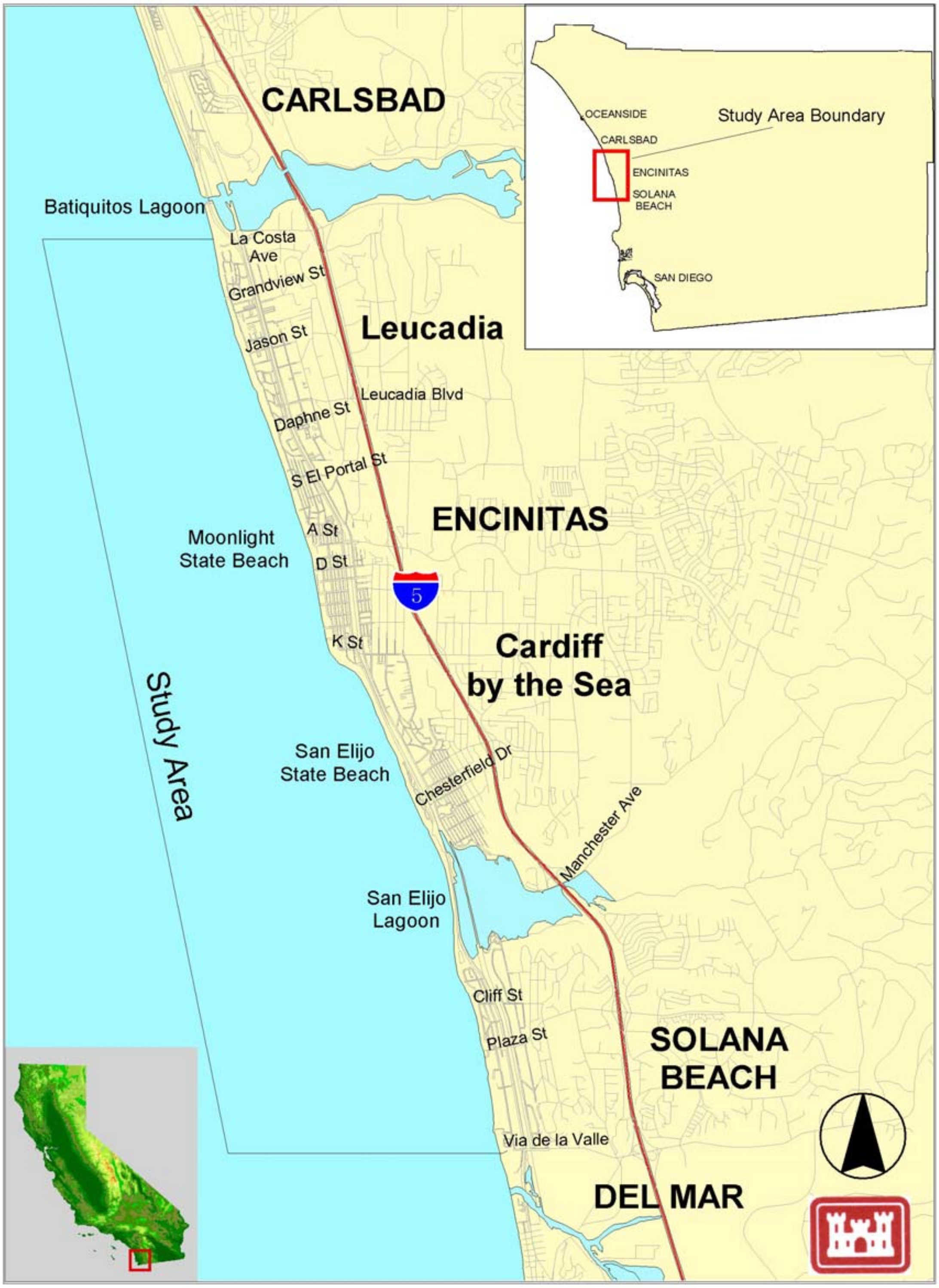
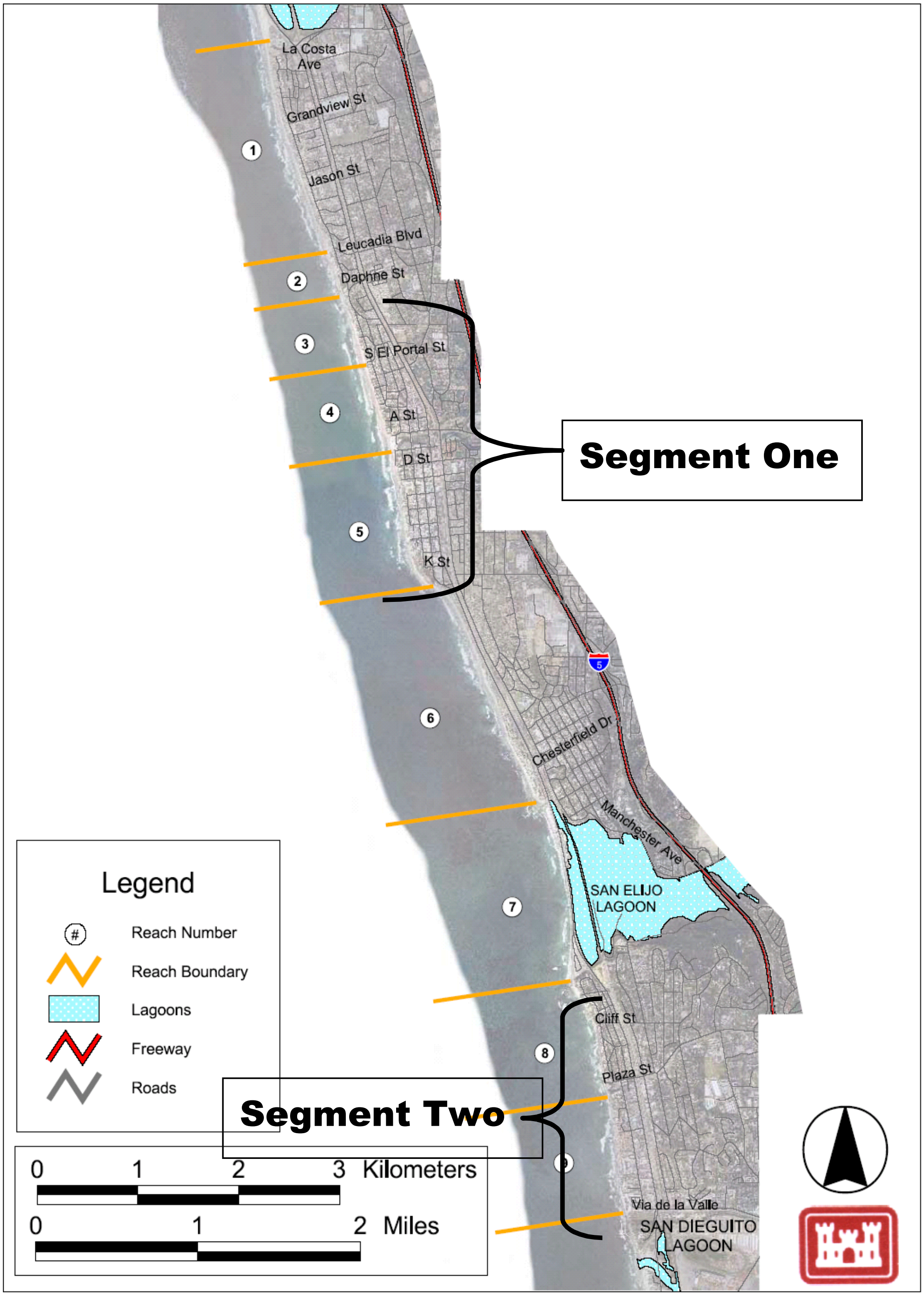


FIGURE ES-2 REACHES AND SEGMENTS



Problems and Needs

In the last 15 to 20 years, The Solana Beach-Encinitas shoreline has experienced accelerated erosion of the beaches and coastal bluffs. As a result, damages occur to bluff top structures when bluffs collapse (Reaches 1 – 6, 8 and 9), and also to private structures and public infrastructure subject to direct wave attack in low-lying areas (Reach 7). The loss of beach has also severely degraded recreational opportunities in all reaches, and the loss of beach combined with the undercutting bluff erosion creates dangerous overhangs, creating a serious public hazard. There have been four fatalities in recent years caused by sudden bluff collapses on northern San Diego County beaches.

Study History

Encinitas Shoreline Reconnaissance Report, San Diego County, California, U.S. Army Corps of Engineers, March 1996. This study found that erosion of the Encinitas Bluffs is caused by wave action against the bluff toe, resulting in bluff instability and failure of the upper bluff. Twelve alternatives, including beachfill, beachfill with groins, seawalls, shotcrete walls, revetments, and cobble berms were evaluated. The reconnaissance report concluded that at that time there was no Federal interest in proceeding to a feasibility phase study because of the lack of an economically justified plan. Since this study was completed, better tools have been developed to evaluate the uncertainty of episodic bluff collapses versus relying on long term erosion trends. With the creation of better models, this feasibility study draws a different conclusion.

Public Law 106-60 (H.R. 2605), the Energy and Water Development Act of 2000, dated September 29, 1999, provided funds to conduct the reconnaissance phase of the coastal bluff erosion problem at the Cities of Encinitas and Solana Beach, California, including investigating opportunities for the ecosystem restoration of San Elijo Lagoon, potentially using sediments from the lagoon to provide shore protection. This was enacted in response to accelerated erosion rates and heightened public safety issues.

Encinitas Shoreline, San Diego County, California, *905(b) Reconnaissance Report* U.S. Army Corps of Engineers, September 2000. This document revisited the problems explored in the 1996 Reconnaissance report in view of accelerating erosion and heightened public safety issues. The local sponsor also requested that the restoration of San Elijo Lagoon be included in any Feasibility Study, and that Solana Beach be added to the study area as a second local sponsor. The current Feasibility study addresses the problems along the shoreline. A separate feasibility study conducted under the same authority and entitled "San Elijo Lagoon Ecosystem Restoration Feasibility Study", when completed, will make recommendations regarding improvements to the lagoon..

Solana Beach Shoreline, San Diego County, California, *905(b) Reconnaissance Report*. U.S. Army Corps of Engineers, September 2000. This document presented the reconnaissance overview and formulation rationale for proceeding into Feasibility Phase to investigate shoreline protection opportunities in the City of Solana Beach, which is adjacent to Encinitas and experiences very similar coastal erosion problems.

Other Relevant Projects - SANDAG

In response to public concerns about erosion, the San Diego Association of Governments (SANDAG) prepared the *Shoreline Preservation Strategy for the San Diego Region* (SANDAG 1993). The Shoreline Preservation Strategy describes a variety of potential solutions to erosion problems, including beach replenishment, structures (e.g., groins) to retain sand, additional structures (e.g., seawalls, sand berms) to protect property, and policies and regulations (e.g., bluff top building setbacks, bluff top irrigation controls) to minimize risk to structures. The report concluded up to 23 million cubic meters (30 million cubic yards) of sand would be needed to initially rebuild San Diego beaches, which would then be followed by smaller sand replenishment projects.

SANDAG only partially implemented the Shoreline Preservation Strategy with completion of the San Diego Regional Beach Sand Project in 2001. 1.6 million cubic meters (2.1 million cubic yards) of sand was placed on twelve San Diego County beaches from Oceanside to Imperial Beach. Four of the beaches were located within the study area -- three in Encinitas and one in Solana Beach.

As SANDAG sands are transported through the littoral system, localized benefits to beaches will shift along the coast until sands are lost from the system. Currently, the SANDAG Project contributes slightly to shoreline protection, the protection is localized and has been gradually decreasing based on natural processes of coastal erosion and littoral transport (Moffatt & Nichol 2000). SANDAG currently has no plans to place any significant amount of additional sand on San Diego beaches.

Without-Project Conditions and Damages

Since the early to mid 1980s, many property owners have been granted emergency permits and instituted emergency stabilization measures in the form of seawalls, rock revetments, and notch infills to protect the base of the bluff from eroding. However, this occurs only after significant loss of blufftop land and danger to the public from sudden bluff collapses.

Approximately half of the shoreline in the study area has been modified with some type of bluff protection structure, at significant cost. Costs were obtained from a survey of actual costs from recent projects in the study area. Typical historic costs for emergency protection range from about $200,000 to $250,000 for a 50 foot wide lot. Over 130 parcels in the study area currently have some type of toe protection, representing over $26 million in total protection costs over the last 25 or 30 years. Land loss is estimated to add at least 40% to that cost. Wherever the bluff toe is protected, marine erosion is generally arrested as long as the shore protection is properly designed, built, and maintained. However, under without project conditions, this will result in a continuation of this piecemeal armoring of the coastline in an inefficient, uncoordinated manner, resulting in a patchwork of different designs and levels of protection.

Without corrective action, both segments will continue to have episodic block failures as the toe is undermined by wave attack. Upper bluff recession will most likely accelerate as the effects of undermining work their way up to the bluff top in areas where the bluff is becoming oversteepened from below.

A model was developed to statistically predict blufftop erosion and the resulting land loss and emergency protection costs for Segments One (Reaches 3, 4, and 5) and Two (Reaches 8 and 9) over the 50 year period of analysis on a parcel by parcel basis. The Table below summarizes the damages thus predicted.

Table ES-1
Annualized Emergency Protection Costs/Land Loss Damages Incurred by Reach

Reach	Annualized Damages
3	$164,817
4	$325,406
5	$467,081
8	$375,792
9	$423,695
Total	$1,756,791

Alternatives Considered

Available methods considered to eliminate or reduce coastal storm damages and shoreline erosion include;

- non–structural measures (best management practices, relocations, etc.)
- seawalls of various designs,
- rock revetments,
- beach nourishment alone,
- beach nourishment with sand retention structures (such as groins and breakwaters), and
- beach nourishment with bluff toe protection (to stabilize lower bluff).

Best Management Practices designed to reduce the rate of erosion have already been implemented in the study area, and no other feasible non-structural measures were identified. Seawalls and revetments are placed parallel to the shoreline as a last line of defense to protect adjacent land areas from direct wave attack, flooding and erosion. As such, they often provide the most reliable form of shoreline protection; however, they do nothing to increase beach width, and can impede public access to the beach. Beach nourishment is highly effective at protecting the coastline as long as the beach is maintained. Sand retention structures such as groins and offshore breakwaters are effective at retaining sand, but they require a healthy source of littoral sand to perform their sand trapping function. Groins would seriously impact public access to the beach and could have significant negative impacts on beach erosion in adjacent areas. Offshore breakwaters are extremely expensive, can also have negative impacts on adjacent beaches and would not be supported by the local sponsors.

After preliminary screening of the alternatives described above, three feasible alternatives were identified which could meet the project objectives, and these were carried into the final analysis;

Alternative 1 – Beach Nourishment Alone

Alternative 1 involves the use of hopper or hydraulic dredges to remove sand from offshore borrow sites and place it on the beach in Segments One and Two. The beachfill design parameters were determined by considering various combinations of beach-fill widths and different replenishment cycles. Each option has one combination of an initial beach width and a repetitive duration for the subsequent renourishment cycles. The optimal option is the one that yields the maximum net benefit. The Corps GENEralized Model for Simulating Shoreline Change (GENESIS) was used to predict the shoreline morphology over multiple years as waves redistribute sand after it is placed mechanically on the beach. The optimization consisted of finding the beach width and renourishment period for both segments that minimized cost while avoiding known sensitive nearshore habitat.

The optimum renourishment cycle was found to be 5 years. **Table ES-2**, below, shows the optimized widths for Segments One and Two.

Alternative 2 – Beach Nourishment with Toe Protection

In Alternative 2, the notches and sea caves at the base of the bluff are filled with erodible concrete to stabilize the lower bluff prior to placement of sand on the beach. The sand would come from the same offshore borrow sites as in Alternative 1, and would mostly bury the notch infills. However, in Alternative 2, the optimized beach width (derived from GENESIS modeling) is narrower by 10 meters. This is because the level of protection provided by the design beach is supplemented by the protection provided by the notch fill. Although the narrower design beach increases the likelihood of the bluff toe being occasionally exposed to wave attack between renourishment episodes, the additional concrete protection at the toe will prevent any significant erosion or undermining during these periods.

Table ES-2 Optimized Beach Widths, Alternatives 1 and 2

SEGMENT	ALT. 1 Width	ALT. 2 Width
One	70m	60m
Two	40m	30m

Alternative 3 – Seawalls

This Alternative entails the construction of seawalls in those areas of Segments One and Two that are unprotected. In Solana Beach there is a large lens of unconsolidated sand in the mid-bluff zone which is not present in Encinitas. Any stabilization measure in Segment Two must therefore extend significantly higher up the bluff face than in Encinitas.
The seawall design in Segment Two is more robust because of these geological differences in the bluff between the two segments. Costs for this alternative reflect these two different seawall designs required for Segments One and Two. **Table ES-3**, below, summarizes the main features and estimated quantities and dimensions for the four alternatives and the no action plan.

TABLE ES-3 COMPARISON OF ALTERNATIVE PLAN FEATURES

	ALTERNATIVE FEATURES			
SEGMENT ONE	**ALTERNATIVE #**			
	No Action	Beach Only	Hybrid	Seawall
Characteristic	ALT. 0	ALT. 1	ALT. 2	ALT. 3
Sand - Initial Vol. (cu.m.)	n/a	732,800	628,100	n/a
Sand - Renourish (cu.m.)	n/a	288,300	261,500	n/a
Design Beach Width	n/a	70m	60m	n/a
Design Beach Length	n/a	7875 ft	7875 ft.	n/a
Linear. Notch Fill (m)	n/a	n/a	2,400	1,789
Linear Seawall	n/a	n/a	n/a	5870 ft
Linear Revetment	n/a	n/a	n/a	n/a
SEGMENT TWO	**ALTERNATIVE #**			
	No Action	Beach Only	Hybrid	Seawall
Characteristic	ALT. 0	ALT. 1	ALT. 2	ALT. 3
Initial Vol. (cu.m.)	n/a	412,800	309,600	n/a
Renourish (cu.m.)	n/a	170,700	140,300	n/a
Beach Width	n/a	40m	30m	n/a
Segment Length	n/a	7220 ft	7220 ft.	n/a
Linear Ft. Notch Fill (m)	n/a	n/a	2,200	2,000
Linear Ft. Seawall	n/a	n/a	n/a	4580 ft

Alternative Costs and Benefits

Under all three alternatives, wherever bluff toe erosion is stopped, some residual slumping of the upper bluff will occur until the bluff face reaches a stable angle of repose. An estimate of the amount of blufftop land that would be lost during the project life as a result of this "stability slumping" was developed. The value of the land lost each year was converted to present value and then annualized. **Table ES-4** below shows average annual damages and the amount of expected "stability slumping" damages that would occur under all three alternatives, by Segment.   **Table 4-xx** previously showed the damages by reach for all reaches, including residual damages. Removing residual damages and removing those reaches where no federal project is justified leaves the following adjusted project benefits:

, below, summarizes the potential benefits after adjustment for residual damages and recreational benefits.

Table ES-4 Residual Damages and Recreation Benefits

Reach	Without Project Damage	With Project "Stability Slumping" Residual Damage	Total Potential Damage Reduction Benefits	Total Potential Damage Reduction Benefits with Recreation
3	$164,817	$9,863	$154,954	$309,908
4	$325,406	$63,440	$261,967	$523,934
5	$467,081	$25,704	$441,377	$882,754
8	$375,792	$18,823	$356,968	$713,936
9	$423,695	$10,647	$413,048	$826096
Total	**$1,756,791**	**$128,477**	**$1,628,314**	$3,256,628

Alternatives 1 and 2 provide the maximum allowable (50% of total) recreational benefits, and Alternatives 3 and 4 provide no recreational benefits. **Table ES-5**, below, summarizes the projected adjusted average annual benefits of the four alternatives.

Table ES-5 Annualized Benefits by Alternative

Table ES-5 Total Annual Benefits

Alternative	Emergency Protection Benefits	Land Loss Benefits	Recreation	Total Benefits
Alt 1. Beach Fill	$802,372	$343,874	$1,146,246	$2,292,500
Alt 2. Hybrid	$903,777	$387,334	$1,291,111	$2,582,200
Alt 3. Seawall	$1,139,819	$488,494	$0	$1,628,300

Table ES-6, below, summarizes the costs of the four alternatives, after optimization of the beach widths and replenishment cycles for Alternatives 1 and 2.

TABLE ES-6 COMPARISON OF ALTERNATIVE PLAN COSTS

Encinitas/Solana Beach Shoreline Feasibility Study Alternative Cost estimates				
Description	Code of	Alternative 1-	Alternative 2-	Alternative 3-
1 Dredging				
Segment 1 Dredge Volume(cu. m)		732,800	628,100	
Unit Cost		$7.03	$7.03	
Segment 2 Dredge Volume (cu. m)		412,800	309,600	
Unit Cost		$6.75	$6.75	
Subtotal		$7,937,984	$6,505,343	
Mob/Demob		$1,430,560	$1,430,560	
Subtotal Dredge Cost		$9,368,544	$7,935,903	
2 Notch fill (LM)				
Segment 1 length (m)			2,400	
Segment 2 length (m)			2,200	
Segment 1 Unit Cost (LM)			$318	
Segment 2 Unit Cost (LM)			$317	
Subtotal Notch fill Cost			$1,459,874	
Subtotal Dredge + Notch fill			$9,395,777	
3 Seawall				
Segment 1 (LM)				
Reinforced Concrete wall (LM)				1,790
Unit Cost (LM)				7,345
Notch Fill (LM)				
Segment 1 Length (LM)				2,400
Unit Cost (LM)				315
Subtotal Segment 1				13,904,565
Segment 2 (LM)				
Reinforced Concrete wall (LM)				1,400
Unit Cost/ (LM)				13,835
Notch Fill (LM)				
Segment 1 Length (LM)				2,200
Unit Cost (LM)				315
Subtotal Segment 2				20,062,486
Subtotal Seawall Cost				33,967,051
Contingency 25%		$2,342,136	$2,348,944	$8,491,763
Total Construction Cost		$11,710,680	$11,744,721	$42,458,814
PED		$2,000,000	$2,000,000	$4,245,881
Construction Mgmt (S&A) 7%		$761,194	$763,407	$2,759,823
First Cost Initial Construction		**$14,471,874**	**$14,508,128**	**$49,464,518**
IDC		$159,000	$138,000	$1,206,000
NPV Future Monitoring Cost		$833,385	$833,385	
NPV Future Dredging		$15,114,101	$14,297,322	
NPV Future Environmental Monitoring Cost		$365,117	$365,117	
Gross Investment		**$30,943,478**	**$30,141,953**	**$50,670,518**
Subtotal Annual Cost		$1,794,100	$1,747,600	$2,937,900
Annual O&M		$25,000	$25,000	$97,600
Total Annual Cost		$1,819,100	$1,772,600	$3,035,500

NED Plan

Analysis of Alternative Costs and NED Benefits reveals that Alternative 2 – the Hybrid Plan, has the highest net NED, as shown in **Table ES-7**, below.

Table ES-7 Annualized Cost/Benefit Analysis, Aternatives 1-3

Table ES-8 Annual Net NED Benefits & B/C Ratios				
Alternative	**Annual Costs**	**Annual Benefits**	**Net NED Benefits**	**B/C Ratio**
Alt 1. Beach Fill	$1,819,100	$2,292,500	$473,400	1.26
Alt 2. Hybrid	$1,772,600	$2,582,200	$809,600	1.46
Alt 3. Seawall	$3,035,500	$1,628,300	($1,407,200)	0.54

Therefore, out of the four final alternatives (including optimization of beach widths), Alternative 2 is the **NED Plan** and the **Recommended Plan**.

Table ES-9 Tentatively Selected Plan Features/Quantities

SEGMENT ONE Characteristic		**SEGMENT TWO Characteristic**	
Initial Vol. (cu.m.)	**628,100**	**Initial Vol. (cu.m.)**	**309,600**
Renourish (cu.m.)	**261,500**	**Renourish (cu.m.)**	**140,300**
Design Beach Width	**60m**	**Beach Width**	**30m**
Design Beach Length	**2.4 km**	**Segment Length**	**2.2 km**
Linear. Notch Fill (m)	**2,400**	**Linear Ft. Notch Fill (m)**	**2,200**

Environmental Impacts

Effects Found Not to Be Significant
Issues that were brought forward for the proposed Encinitas and Solana Beach Shoreline Protection Project for further analysis and included in the accompanying Draft EIS/EIR included topography, geology and geography, oceanographic and coastal processes, water and sediment quality, biological resources, cultural resources, noise, socioeconomics, transportation, land use, recreation, public safety, and public utilities. This analysis determined that the proposed project would not have a long-term significant effect on these elements.

Significant Unavoidable Adverse Effects
The EIS/EIR considered the potential impacts of the three proposed alternatives, in addition to the No Action Alternative, according to several resource categories: topography, geology and geography, oceanographic and coastal processes, water and sediment quality, biological resources, cultural resources, aesthetics, air quality, noise, socioeconomics, transportation, land use, recreation, public safety, and public utilities. Significant impacts have been identified for impacts to air quality under Alternatives 1 and 2 and aesthetics under Alternative 3.

Environmental Commitments
Table ES-3 shows the environmental commitments to be undertaken by the Corps to ensure environmental impacts are reduced to a level of insignificance where possible.

Table ES-10.
Summary of design features/monitoring commitments and mitigation measures (if necessary).

	Purpose	Timing	Implementation Responsibility
Design Features			
Topography, Geology, and Geography: Use of erodible concrete for notch fill material	Mimic natural erosive processes	During notch fill	Construction contractor
Oceanographic Characteristics and Coastal Processes: Use of erodible concrete for notch fill material	Mimic natural erosive processes	During notch fill	Construction contractor
Water and sediment quality: Construct "L"-shaped berms at all receiver sites	Anchor sand placement operations and reduce nearshore turbidity	During beach fill	Construction contractor
Water and sediment quality: Maintenance for land-based vehicles will occur in staging area away from beach and sensitive areas	Avoid minimal contamination from leaks, if any	During beach nourishment/notch fill	Construction contractor
Water and sediment Quality: Use proper BMPs during vehicle fueling	Avoid petroleum spills	During beach nourishment/notch fill	Construction contractor
Water and sediment quality: Generate plan for hazardous spill prevention and containment	Ensure minimal contamination from fuel leaks, if any	During operation of equipment on the beach or in the water	Construction contractor
Biological Resources: Design borrow sites to maintain adequate distance from artificial reefs, kelp, and other features	Avoid direct impacts to artificial reefs and kelp	Final engineering and during construction	Engineering contractor and construction contractor
Biology: Construct second transverse berm to begin a new cell if grunion spawning or eggs are encountered during construction	Section of beach with grunion would be avoided and bypassed	If grunion spawning or eggs are encountered	Construction contractor, in coordination with USACE
Biology: No construction shall be performed within 430 m of any sensitive bird species that have clear line of site to the construction area during breeding and nesting season; no beach construction within 215 m of any sensitive bird species during the breeding and nesting season	Minimize impacts to sensitive wildlife of noise emissions	During beach nourishment/notch fill	Construction contractor
Air quality: Use of BMPs to reduce air quality impacts such as the use of BACT and/or BART for the dredge	To reduce air emissions	During all construction activities	Construction contractor
Air quality: Construction equipment will be properly maintained and tuned	To reduce air emissions	During beach nourishment/notch fill	Construction contractor
Noise: Construction equipment shall be fitted with mufflers, air intake silencers, and engine shrouds; stationary noise sources will be located far from residential receptor locations	Minimize noise emissions	During beach nourishment/notch fill	Construction contractor
Noise: A noise variance shall be obtained for work done after 7 pm from the City of Encinitas and the City of Solana Beach	Public notification and approval	Prior to the commencement of any work	Construction contractor
Noise: In Reach 8, no beach construction shall be performed within 430 m (1,400 ft) of any sensitive bird species that have a clear line of sight to the construction area during the breeding and nesting season; and no beach construction shall be performed within 240 m (790 ft) of any sensitive bird species during the breeding and nesting season	Minimize impacts to sensitive wildlife of noise emissions	During beach nourishment/notch fill	Construction contractor
Recreation: Communicate with local jurisdictions to avoid recreational events	Avoid disruption of established recreational events	During beach nourishment/notch fill	Construction contractor
Public safety: Avoid placing fill material near storm drain outlets	Continue proper drainage	During beach nourishment/notch fill activities	Construction contractor, in coordination with City Engineer

Table ES-10.
Summary of design features/monitoring commitments and mitigation measures (if necessary).

	Purpose	Timing	Implementation Responsibility
Public safety: Generate plan for hazardous spill prevention and containment	Ensure minimal contamination from fuel leaks, if any	During operation of equipment on the beach or in the water	Construction contractor
Public Safety: Issue Notice to Mariners and maintain 500-foot buffer around active dredge equipment	Warn boaters/fishermen of dredging activities to ensure avoidance	Before and during dredging activities	Coast Guard (via construction contractor)
Public Safety: Generate safety plan to restrict public access at receiver and notch fill sites and maintain 45-m (150-foot) buffer around construction areas	Public safety during construction	During beach nourishment/notch fill activities	Construction contractor, in coordination with local lifeguards
Public Safety: Relocation of temporary lifeguard towers	Public safety during construction	During beach nourishment activities/notch fill	Construction contractor, in coordination with local lifeguards
Public Safety: Sand placement to avoid blocking line-of-sight at permanent lifeguard towers	Public safety during construction	During beach nourishment activities	Construction contractor, in coordination with local lifeguards
Socioeconomics: Coordination with commercial fishermen; establishment of offshore transit corridors in consultation with a commercial fishermen representative; issue Notice to Mariners	Avoid gear conflicts and provide for compensation if loss occurs	Before and during dredging operations	Coast Guard (via construction contractor) and USACE
Monitoring Commitments			
Water and Sediment Quality: Monitor turbidity levels	To avoid turbidity impacts to fish and aquatic species	During dredging operations and beach fill activities	
Biology: Conduct nearshore underwater surveys	Establish baseline data for comparison purposes and determine if any natural/ biological resources/habitats have been adversely impacted by the project	Prior to construction and after construction	Qualified biologist
Biology: Monitor weekly for grunion spawning in construction area, establish buffer extending 30 m shoreward of high tide line and 30 m upcoast and downcoast (total 200 feet), until eggs hatch (minimum of one lunar month) and surveys show no subsequent spawning	Avoid grunion eggs and protect until hatched	April through September and per CDFG annual pamphlet *Expected Grunion Runs*.	Qualified biologist
Public Safety: Generate safety plan to restrict public access at receiver and notch fill sites and maintain 45-m (150-foot) buffer around construction areas	Public safety during construction	During beach nourishment/notch fill activities	Construction contractor, in coordination with local lifeguards
Post-Project Mitigation Measures (If Necessary)			
Biology: Restoration or creation of like habitat at a ratio to be determined with the responsible resource agencies according to the long-term significant impacts, if any, to marine resources	Mitigate for significant, long-term Impacts, if any, to sensitive marine resources caused by sediment placement or transport	Subsequent to resource agency review of monitoring reports and determination that significant impact had occurred	Qualified biologist

Recommended(National Economic Development) Plan Description

The Recommended Plan consists of two components: notch fill at the bluff base and sand nourishment on the beach.

Notch fill- The construction procedure consists of scraping sand layer away to expose the bedrock layer; and sealing up eroded notches with erodible concrete. The shotcrete gunite with special grout material is typically used for the notch-fill construction as it builds up the concrete seal layer-by-layer and is less impacted by the rising tides. The construction equipment required includes a backhoe for sand scraping and a high-pressured nozzle for concrete fill. In Segment 1, the The notch fill will extend approximately 2.4 km along the toe of the bluff in Segment 1 and approximately 2.2 km in Segment 2 The particular design for a notch fill is based on the geotechnical characteristics of the area and the size of the notch The size and quantity of notch fill will depend on depth and height of notch at each specific location.

Beach fill- In Segment 1, approximately 628,100 cm of beach quality sand would be initially placed along 2.4 km (1.5 mi) of shoreline providing a nourishment width of 60 meters at a berm elevation of approximately +3.9 meters (+12.8 feet) Mean Lower Low Water (MLLW). The berm would be flat and approximately 60 meters wide. The beach fill would then naturally slough seaward approximately 43 meters (134 feet) at a slope of 10:1 (horizontal distance:vertical distance). The beach fill will be tapered into the existing beaches to the north and south of the segment. Beach replenishment of an additional sand volume of 261,500 cm would occur on average every 5 years within the 50-year project lifetime.

In Segment 2, approximately 309,600 cm of beach quality sand would be initially placed along 2.2 km of the shoreline, providing a nourishment width of 30 meters at a berm elevation of approximately +3.9 meters (+12.8 feet) Mean Lower Low Water (MLLW). The berm will be flat and approximately 30 meters wide. The beach fill would then naturally slope seaward approximately 38 meters (119 feet) at a slope of 10:1 (horizontal distance:vertical distance). The beach fill will be tapered into the existing beaches to the north and south of the segment. Beach replenishment of an additional sand volume of 140,300 cm would occur on average every 5 years within the 50-year project lifetime. **Table ES-X** summarizes the costs and benefits of the Recommended Plan.

Table ES-11 Recommended Plan Economic Analysis

Recommended Plan Economic Analysis			
Reach	**Without Project Damages**	**Recommended Plan Residual Damages**	**Benefits**
Segment 1	$957,304	$219,240	$738,100
Segment 2	$799,487	$246,441	$553,000
Total Damage Benefits			$1,291,100
Recreation Benefits			$1,291,100
		Total Annualized Benefits	$2,582,200
		Total Annualized Costs	$1,772,600
		Benefit-to-Cost Ratio	1.46
		Net Benefit	**$809,600**

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Chapter 1. Introduction

1.1 Study Authority

The Solana Beach and Encinitas Shoreline Feasibility Study was authorized by a 13 May 1993 Resolution of the House Public Works and Transportation Committee, that reads as follows:

"Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, That, in accordance with Section 110 of the River and Harbor Act of 1962, the Secretary of the Army, acting through the Chief of Engineers, is directed to make a survey to investigate the feasibility of providing shore protection improvements in and adjacent to the City of Encinitas, California, in the interest of storm damage reduction, beach erosion control, and related purposes."

And, a 22 April 1999 Resolution of the House Committee on Transportation and Infrastructure, that reads as follows:

Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army, in accordance with Section 110 of the River and Harbor Act of 1962, is hereby requested to conduct a study of the shoreline along the City of Solana Beach, San Diego County, California, with a view to determining whether shore protection improvements for storm damages reduction, environmental restoration and protection, and other related purposes are advisable at the present time.

Public Law 106-60 (H.R. 2605), the Energy and Water Development Act for FY2000, dated September 29, 1999, provided funds in the amount of $100,000 to conduct the reconnaissance phase of the coastal bluff erosion problem at the Cities of Encinitas and Solana Beach, California, including investigating opportunities for the ecosystem restoration of San Elijo Lagoon, potentially using sediments from the lagoon to provide shore protection. The reconnaissance analysis (Section 905 (b), WRDA 96), which was initiated on 28 March 2000, found that there is a Federal interest in continuing the study into the feasibility phase. The lagoon restoration and shoreline protection investigations were joined in one feasibility study to facilitate this potential beneficial re-use of lagoon sediment for beach nourishment.

Recently, the lagoon restoration and the shoreline protection investigations were split into two separate feasibility studies. This document describes the findings and recommendations for shoreline protection and is therefore an interim response to the study authority. The final feasibility study of the ecosystem restoration opportunities within the San Elijo lagoon, will complete the response to the study authority.

1.2 Study Purpose and Scope

The purpose of this Feasibility Study is to:

1) Describe existing and future without-project conditions of the study area and identify problems and opportunities to reduce storm damages, improve public safety, increase recreation opportunities, and protect the environment.

2) Formulate and evaluate an array of alternatives and recommend the one that most effectively addresses these problems and complies with local, state, and Federal laws and regulations. Three accounts are used to evaluate the plans, the National Economic Development (NED) account, the Regional Economic Development (RED) account, and the National Environmental Restoration (NER) account. These three accounts quantify (respectively) benefits to the national economy, the regional economy, and the environment.

1.3 Planning Process and Report Organization

This report includes the alternatives analysis, which develops options that focus on the reduction of storm damages. The alternatives are evaluated, and preliminary recommendations are made. This feasibility study was conducted in accordance with current Corps of Engineers regulations and policies including, but not limited to the Principles and Guidelines for Water Resources and ER 1105-2-100, Planning Guidance notebook (22 April 2000), Guidance for Conducting Civil Works Planning Studies, (Dec 1990). The six steps in plan formulation, which are expanded in the aforementioned documents, are listed below and discussed further in Chapter 6.0, Plan Formulation.

1. Identify Problems and Opportunities
2. Inventory and Forecast Conditions
3. Formulate Alternative Plans
4. Evaluate Alternative Plans
5. Compare Alternative Plans
6. Select a Recommended Plan

1.4 Study Participation and Coordination

The non-Federal co-sponsors of this study are the Cities of Solana Beach and Encinitas whose representatives have taken an active role in support of this study. Numerous local, state, and federal agencies were also involved in the study effort, and these are listed below. This Feasibility Study is funded with 50% Federal and 50% non-Federal funds.

The Cooperating/Consulting Public Agencies and Institutions that participated in the Solana Beach-Encinitas Shoreline Feasibility Study include:

U.S. Fish and Wildlife Service
National Marine Fisheries Service
State of California
    Department of Fish and Game
    Department of Boating and Waterways
San Elijo Lagoon Conservancy
California Coastal Conservancy
University of California San Diego
    Department of Geotechnical Engineering
    Scripps Institute of Oceanography
    Supercomputer Center
San Diego County Department of Parks and Recreation
Southern California Coastal Water Research Project
Southern California Wetlands Recovery Project
San Diego Association of Governments

1.5 Prior Studies and Related Projects

There have been numerous studies and projects along the shoreline of the Cities of Solana Beach and Encinitas by the Corps and other entities.

1.5.1 Corps of Engineers Studies and Reports

Previous Corps of Engineers studies, reports and projects are listed below.

1. *Coastal Cliff Sediments, Coast of California Storm and Tidal Wave Study, San Diego Region*, Corps of Engineers, 1987 and 1988. The report documents erosion of the cliffs along Leucadia, Encinitas and Cardiff. Severe beach and cliff erosion is documented at numerous locations during the stormy winters of 1978, 1980, and especially 1983. The sediment yield resulting from the bluff erosion is estimated at three bluff locations, San Onofre, Camp Pendleton and Torrey Pines.

2. *Sediment Budget Report, Oceanside Littoral Cell*, *Coast of California Storm and Tidal Wave Study, San Diego Region,* Corps of Engineers, 1990. The report summarizes shoreline changes, sediment volume changes and historical sediment budget within the Oceanside Littoral Cell. It concludes that the Mean Sea Level (MSL) shoreline was relatively stable between 1933 and 1988 in the Leucadia through Cardiff reach.

3. *State of the Coast Report, Coast of California Storm and Tidal Wave Study, San Diego Region, Main Report*, Corps of Engineers, 1991. The report suggests that the condition of the beaches in the future will be governed by cycles of accretion and erosion similar to those of the past 50 years. However, there will be accelerated trends toward erosion because of the reduction in fluvial delivery due to impediment by dams and river mining, the influence of Oceanside Harbor interrupting longshore sediment transport, and the increasing rate of sea level rise.

4. *Encinitas Shoreline Reconnaissance Report, San Diego County, California*, U.S. Army Corps of Engineers, March 1996. The findings indicate that erosion of the Encinitas Bluffs is caused by wave action against the bluff toe, resulting in bluff instability and failure of the upper bluff. The most critical reach has narrow or nonexistent beaches, steep seacliffs and private residences located close to the bluff top edge. Twelve alternatives, including beachfill, beachfill with groins, seawalls, shotcrete walls, revetments, and cobble berms are evaluated. Studies indicate that toe protection alone would provide some benefits, but that major damages would still result from upper slope instability. The reconnaissance report concluded that there was no Federal interest in proceeding to a feasibility phase study because of the lack of an economically justified plan.

5. *Encinitas Shoreline, San Diego County, California*, *905(b) Reconnaissance Report* U.S. Army Corps of Engineers, September 2000. This document revisits the problems explored in the 1996 Reconnaissance report in view of accelerating erosion and heightened public safety issues. The local sponsor also requested that the restoration of San Elijo Lagoon be included in any Feasibility Study, and that Solana Beach be added to the study area as a second local sponsor. The current Feasibility study incorporates these requests.

6. *Solana Beach Shoreline, San Diego County, California*, *905(b) Reconnaissance Report*. U.S. Army Corps of Engineers, September 2000. This document presents the reconnaissance overview and formulation rationale for proceeding into Feasibility Phase to investigate shoreline protection opportunities in the City of Solana Beach, which is adjacent to Encinitas and experiences very similar coastal erosion problems.

1.5.2 Other Studies and Reports

The following reports from consultants and public entities have been reviewed as part of this study. This list contains only the reports that were most relevant and useful to the Feasibility Study; a comprehensive list may be found in the bibliography.

1. *Shoreline Erosion Evaluation, Encinitas Coastline, San Diego County, California*, Group Delta Consultants, 1993. This report details the results of a comprehensive study to evaluate variations in shoreline erosion susceptibility in the Encinitas area. The report documents historical changes of shoreline and climate within the study area. The long-term marine erosion as well as the subaerial erosion of the bluffs is estimated to range from 0.0303 to 0.0365 meter/year (0.1 to 0.12 ft/year) within the Stone Steps area.

2. *A Technical Report on Historical Marine Process Within the City of Encinitas*, City of Encinitas, 1994. This report presents the findings of an investigation of geotechnical conditions and historical erosion. It presents estimates of seacliff retreat rate and shore platform down wearing, and suggests general coastal erosion remedies such as mitigation alternatives, planning options and policy recommendations.

3. *Shoreline Erosion Assessment and Atlas of the San Diego Region, Volumes I & II*, California Department of Boating and Waterways and San Diego Association of Governments, 1994. This report presents the findings of a study assessing shoreline erosion and recommends shore and beach management tactics within San Diego County. From Oceanside to La Jolla, the report recommends that measures such as artificial beach enhancement and hard structures for beach stabilization be further evaluated.

4. *Draft Encinitas Comprehensive Plan to Address Bluff and Beach Recession*, City of Encinitas, 1995. The draft report addresses the criteria for the implementation of beach and bluff stability measures. The plan provides technical merits for minimum setback requirement at the bluff top, various shore/bluff protection alternatives, upper bluff stability, and the aesthetic aspects of any shore protective device. The comprehensive plan provides the standard for local policy to be implemented for comprehensive bluff stability and beach erosion prevention measures.

5. *Shoreline Erosion Study – North Solana Beach, California*, Group Delta Consultants, August 1998. This document presents an evaluation of shoreline erosion currently affecting the coastal bluffs within the northern portion of Solana Beach. It addresses the geotechnical aspects of shoreline erosion and provides a technical basis for any proposed shoreline and bluff protection measures.

6. *Protection of Highway 101* – City of Encinitas (Moffatt, Nichol), Dec. 1998. This document provides environmental, civil, and geotechnical analyses for existing conditions of the shoreline at Cardiff, where Hwy 101 is frequently closed due to wave attack during storm events. It formulates and assesses an array of alternatives to protect Hwy 101, including beach replenishment, structural protection, and storm drain improvements.

7. *Environmental Impact Report/Assessment (and Shoreline Morphology Study) for the San Diego Regional Beach Sand Project,* San Diego Association of Governments (SANDAG), June 2000. This document presents the environmental impacts of two different beach nourishment alternatives covering up to 13 receiver sites in San Diego County, including three within the study area. It includes extensive data on environmental resources in the study area.

8. *Shoreline Morphology Study – Appendix C of the SANDAG EIR,* SANDAG/KEA Environmental, March 2000. This document models the shoreline areas impacted by the Regional Beach Sand Project and predicts the general behavior and movement of the sediment that is placed at the receiver sites and projects the study area beach morphology.

9. *Observations on the Status of Biological and Physical Intertidal Resources Along the Coastline of Encinitas,* City of Encinitas, March 2000. This document (whose title is sufficiently descriptive of its scope) was produced to address concerns about impacts on sensitive nearshore environments from any beach nourishment activity. It includes detailed information on intertidal and nearshore habitats in portions of the study area.

10. *SANDAG Post construction monitoring studies* – (Placeholder)- these studies are not yet completed. The Public Draft will contain a summary of findings to date.

1.5.3 Existing Corps of Engineers Projects

Oceanside Harbor

Oceanside Harbor, approximately 10 miles north of the study area, is dredged approximately once a year as part of an ongoing Corps operations and maintenance program. Approximately 175,000 cubic yards (133,800 cubic meters) of material are bypassed and placed on down coast beaches annually. The effects of the nourishment are not easily discernible more than a few miles from the placement site, and have little or no impact on the study area beaches.

1.5.4 Other Existing Coastal Structures/Projects

Man-made structures have been constructed in localized areas by cities, residents, and business owners to protect coastal structures, whose vulnerability has increased with increased beach erosion. A variety of methods and materials have been used, including bluff notch (sea cave) filling, rock riprap revetment, seawalls, and concrete-based facing (shotcrete) of bluff sections. Over the last couple of decades, approximately half of the coastline in the study area has been armored to some degree in response to bluff failures, wave damage, and flooding. These measures have exhibited a wide range of effectiveness and design life. **Figure 1-1** shows the study area.

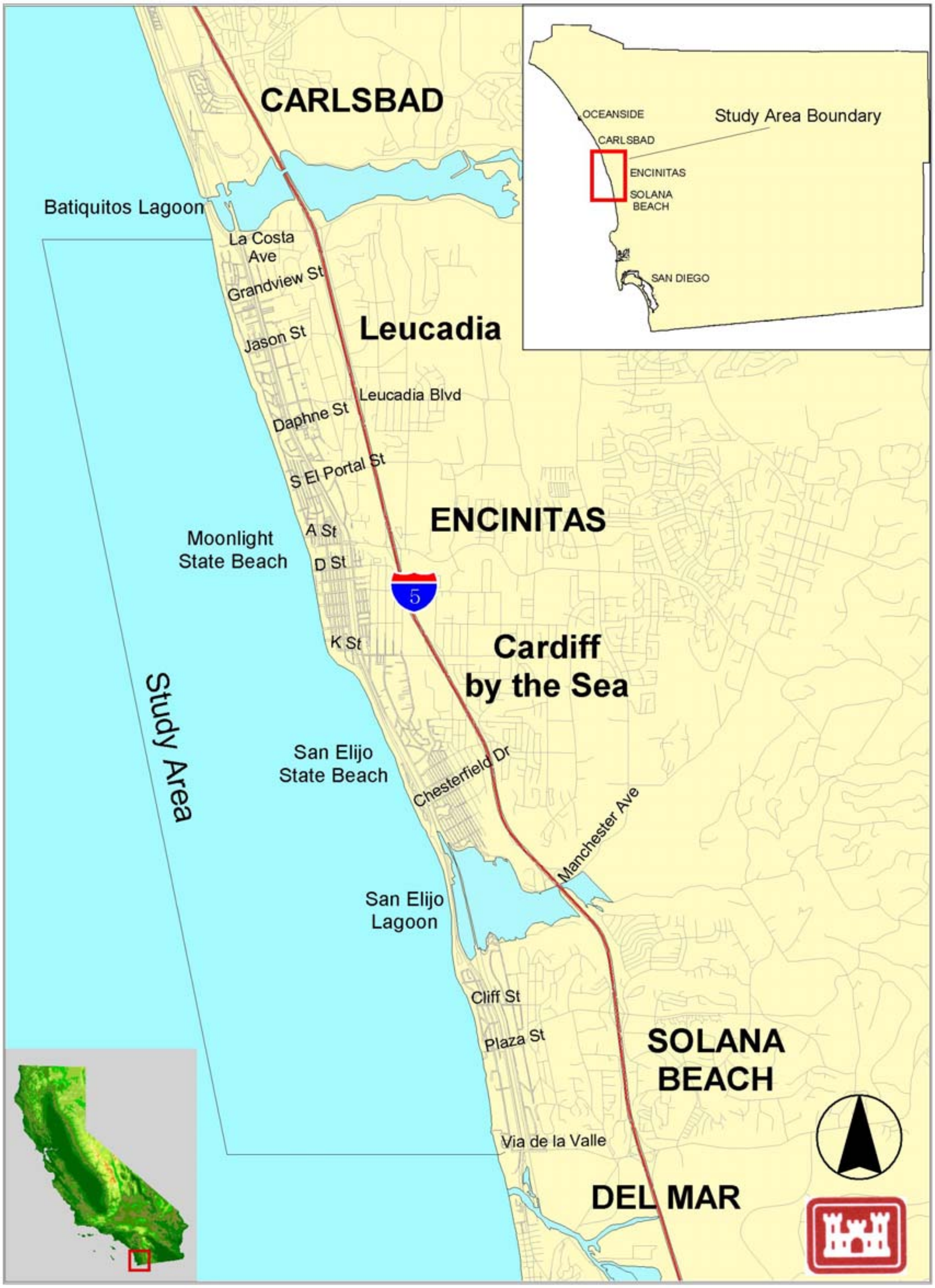
1.5.5 SANDAG Shoreline Preservation Strategy/Regional Beach Sand Project

In response to public concerns about erosion, the San Diego Association of Governments (SANDAG) worked with member jurisdictions to prepare the Shoreline Preservation Strategy for the San Diego Region (SANDAG 1993). The Shoreline Preservation Strategy describes a variety of potential solutions to erosion problems, including beach replenishment, structures (e.g., groins) to retain sand, additional structures (e.g., seawalls, sand berms) to protect property, and policies and regulations (e.g., bluff top building setbacks, bluff top irrigation controls) to minimize risk to structures. A total of up to 23 million cubic meters (30 million cubic yards) of sand was recommended to initially rebuild San Diego beaches, which would then be followed by smaller, sand maintenance projects. The need for further studies was identified before site-specific locations for additional man-made structures could be recommended.

As part of the Shoreline Preservation Strategy, SANDAG implemented the San Diego Regional Beach Sand Project in 2001 and placed 1.6 million cubic meters (2.1 million cubic yards) of sand on twelve San Diego County beaches ranging from Oceanside to Imperial Beach. Four of the beaches were located within the study area -- three in Encinitas and one in Solana Beach.

While the SANDAG Project currently contributes to shoreline protection, the protection is localized and predicted to last from one to five years based on natural processes of coastal erosion and littoral transport (Moffatt & Nichol 2000). As SANDAG sands are transported through the littoral system, localized benefits to beaches will shift along the coast until sands are lost from the system. It is predicted that benefits to the beaches will not be discernible five years after sand placement. A five-year sand monitoring program (currently in its third year) will produce data that will be used to determine the effectiveness of the project. In addition, SANDAG has published the "*Regional Beach Sand Retention Strategy*", prepared by Moffatt & Nichol Engineers and released in Oct. 2001. This study outlines various alternative sand retention strategies and also provides a survey and analysis of natural and artificial sand retention structures in Southern California.

FIGURE 1-1. SOLANA BEACH-ENCINITAS STUDY AREA AND LOCATION



area.

1.5.6 Maintenance Dredging and Bypassing

Other smaller sand replenishment projects routinely occur as a result of maintenance dredging of Batiquitos and Agua Hedionda Lagoons and sand bypassing of Oceanside Harbor. The bypassing and maintenance dredging from flood shoals at various lagoons do not increase beach width in the long term, but only maintain the status quo; a deficient sediment budget. Without these activities, the downcoast beaches would be further depleted due to sand being trapped by the jetties or in the lagoon entrance channels. The sediment bypassing program at Oceanside Harbor was implemented as a consequence of shoreline erosion occurring downcoast of the harbor after the jetty construction was completed.

- San Dieguito Lagoon, located approx. 1 km south of the southern boundary of Solana Beach, has only occasional minor maintenance dredging, which has no impact on the study area beaches.

- Batiquitos Lagoon, which is located immediately north of the study area, requires regular maintenance dredging and sand placement since its restoration in 1995-1996 -- approximately 57,337 cubic meters (75,000 cubic yards) of sand was dredged and placed on the beach in 2002-2003.

- Agua Hedionda Lagoon, which is located approximately 6 kilometers (4 miles) north of the study area, is dredged every one to three years depending upon sedimentation rate and volume, and sands are placed on Carlsbad beaches north and south of the lagoon. Approximately 306,000 cubic meters (400,000 cubic yards) of sand was placed on Carlsbad beaches in 2000-2001, and a similar amount is slated for dredging and disposal in 2002-2003 (MEC 2002).

- Oceanside Harbor, which is located 16 kilometers (10 miles) north of the study area, bypasses approximately 133,787cubic meters (175,000 cubic yards) of sand to beaches south of the harbor each year; a total of 207,944 cubic meters (272,000 cubic yards) was placed on beaches in 2000 (SANDAG 2000a).

These maintenance projects contribute to wider beaches in Oceanside and Carlsbad, but that protection does not extend beyond the shoreline of those cities. These maintenance projects have little potential to significantly affect beaches within the Encinitas and Solana Beach shoreline. The small volumes of sand placed on the beach from maintenance of Batiquitos Lagoon would be expected to have only limited influence on the beach at the northern end of the study area and would have no discernible effect further downcoast. Dredging of the entrance channel at San Elijo Lagoon places anywhere from 25,000 to 40,000 cubic yards per year onto the downcoast beaches, having little or no long term effect on the beach width.

Chapter 2. Study Area

2.1 Study Geographic and Jurisdictional Setting

The Solana Beach-Encinitas shoreline study area is located along the Pacific Ocean in the Cities of Solana Beach and Encinitas, San Diego County, California. Encinitas is approximately 16 kilometers (10 miles) south of Oceanside Harbor, and 27 kilometers (17 miles) north of Point La Jolla. The Encinitas shoreline is about 9.6 kilometers (6 miles) long. It is bounded on the north by Batiquitos Lagoon and on the south by San Elijo Lagoon. The 1,500-meter-long (4,920 feet) southernmost segment of the Encinitas shoreline is a low-lying barrier spit fronting the San Elijo tidal lagoon.

Immediately south of Encinitas is the City of Solana Beach. Solana Beach is bounded by San Elijo Lagoon to the north and on the south by the City of Del Mar. It is approximately 27 kilometers (17 miles) south of Oceanside Harbor, and 16 kilometers (10 miles) north of Point La Jolla. Solana Beach's shoreline is about 3.2 kilometers (2 miles) long. Nearly all of the shoreline in the study area except Cardiff (8 miles total) consists of narrow sand and cobble beaches fronting nearshore bluffs.

The study area is located in the 51st Congressional District currently represented by Randy “Duke” Cunningham (R).

2.2 Physical Description

2.2.1 Regional Topography

The study area is located within the coastal plain of the Peninsular Ranges geomorphic province of southern California. This Province is characterized by a flat coastal plain with steep sloped hills and a series of northwest to southwest trending elongate mountain ranges dissected by faults and separated from one another by alluvial valleys. The coastal plain consists of marine and non-marine terraces dissected by coastal lagoons. Elevations range from sea level to approximately 30 meters (100 feet) at the tops of the coastal bluffs.

Terrestrial topographic data was obtained from two sources. Both an aerial photogrammetric survey and an aerial Laser Interferometry Detection and Ranging (LIDAR) survey were conducted as part of this study. Topographic maps compiled from the data allowed detailed information to be collected of the beach, shoreline structures, and blufftop ground elevations.

2.2.2 Regional Bathymmetry-Nearshore Profile

Representative cross shore beach profiles developed as part of the SANDAG Regional Beach Sand Project substantiate previously known trends. The nearshore contours are relatively straight and parallel. On average, the shoreline is characterized by an approximate beach face slope of 45:1 (horizontal feet to vertical feet), extending from the base of the coastal bluffs to about –3 meters (-10.0 feet) below the mean lower low water, MLLW, vertical datum. The nearshore slope extending seaward to approximately the –12-meter (-40-foot) elevation contour is about 70:1. It should be noted that the beach face and nearshore slopes at Leucadia in the City of Encinitas are on average somewhat steeper than those to the south. The regional bathymetry seaward of the subject coastlines is presented in **Figure 2-1.**

2.2.3 Climate

The semi-arid climate of the area is the subtropical Mediterranean climate typical of coastal southern California, and is characterized by warm, dry summers and mild winters. Temperatures average 12 degrees C (54 degrees F) in January and 21 degrees C (70 degrees F) in August. The average amount of precipitation along the coastal area is about 254 millimeters (10 inches) annually, and occurs primarily from November to March. Most of the rainfall occurs during winter storms, and fog is common during the winter months. Winds are generally of low velocity, and the prevailing winds are from the northwest and west, blowing onshore nearly every afternoon. Tropical storms generated in the Pacific Ocean occasionally bring stronger winds, but these are generally of short duration.

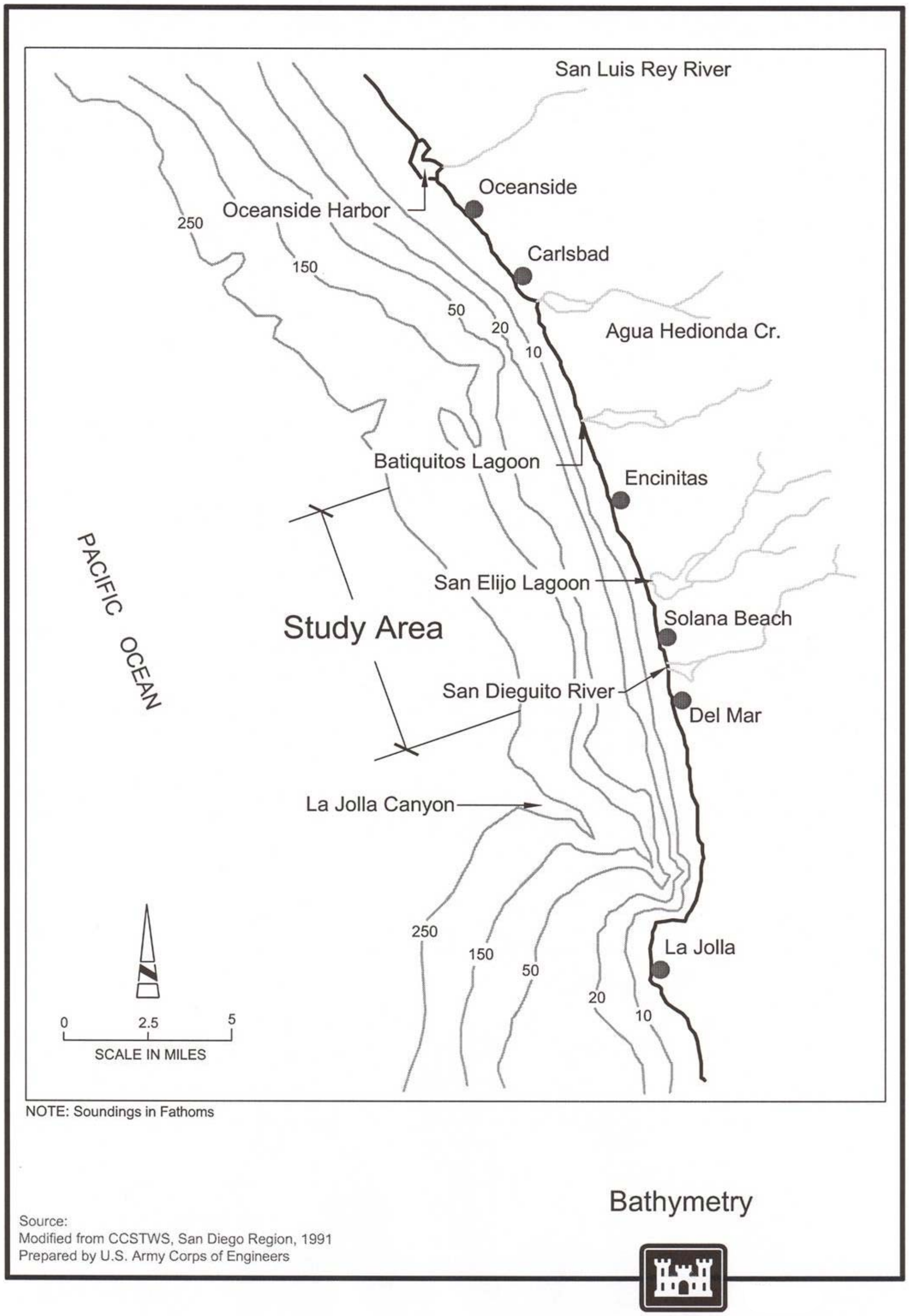
2.3 Geotechnical Conditions

This section provides a summary of geotechnical information gathered for the study. Detailed descriptions of geotechnical investigations, analyses, discussion of methodologies, and relevant tables are presented in the Appendix D, the Geotechnical Appendix.

2.3.1 Onshore Geology

Geologic units in the Encinitas and Solana Beach coastal bluffs include dune sands and marine terrace deposits that form the sloping, upper coastal bluffs above the sea cliffs and three older Eocene “bedrock” geologic units. The sequence of formational material from north to south of the Encinitas segment is the Santiago, Torrey Sandstone and Delmar Formations. Within the Solana Beach area, the geological units exposed are the Delmar formation on the northern segment and the Torrey Sandstone on the southern portion.

FIGURE 2-1. OFFSHORE BATHYMETRY



The bluff-forming units overlie a wave-cut abrasion platform formed on the Eocene bedrock approximately 125,000 years ago when sea level was 6 meters (20 feet) higher (Lajoie and others, 1992). The sloping, upper portion of the Encinitas and Solana Beach bluffs is comprised predominantly of late Pleistocene, moderately-consolidated, silty-fine sands. Sand dune deposits locally cap the coastal terrace.

Figure 2-2 shows a rough schematic of major geological features. A more detailed description of bluff geology may be found in **Section 2.4**, Description of Reaches.

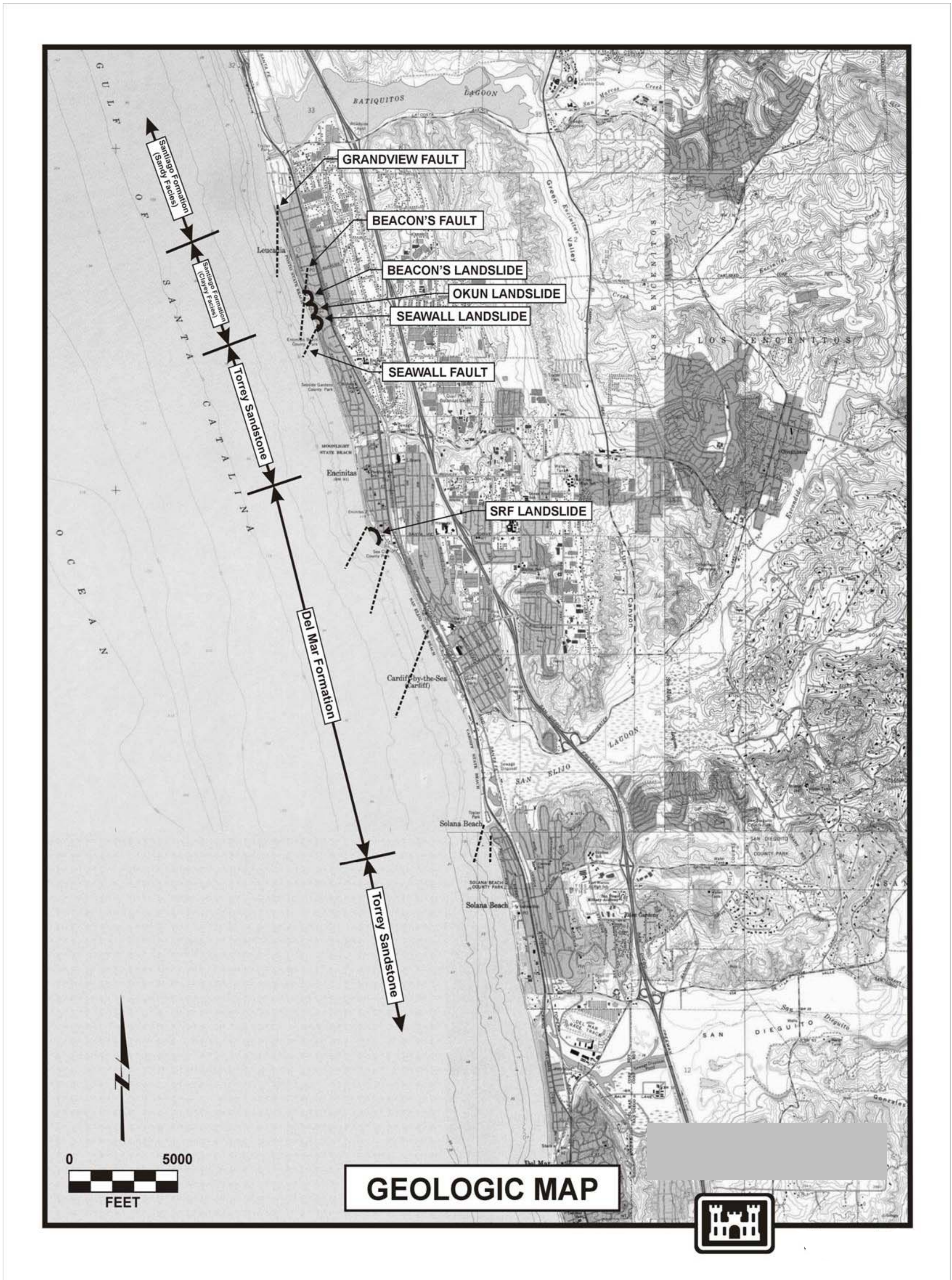
2.3.2 Offshore Geology

Offshore from the bluffs, a shore platform extends152 to 274 meters (500 to 900 feet) seaward at a slope of 1.25 degrees to a depth of 3.65 meters (12 feet), followed by a steeper slope of 1.75 degrees to depths of over 18 meters (60 feet). This surface is an active wave-cut abrasion platform subject to erosion in the present wave environment. The platform is underlain by the same Eocene-age claystone, shale and sandstone bedrock formations exposed in the sea cliffs. Gentle folding of the bedrock has imparted a northwestward inclination of a few degrees. As a result, the outcrops of individual bedrock formations in the shore platform are located southerly of their position in the coastal bluffs. Where the less erosion-resistant Torrey Sandstone underlies the platform, deeper water extends closer to the bluffs.

2.3.3 Seismicity

The geologic structure of the Encinitas and Solana Beach region is the result of faulting and folding in the current tectonic regime, which began approximately five million years ago when the Gulf of California began to open in association with renewed movement on the San Andreas fault system (Fisher and Mills 1991). The tectonic forces are also evident in the localized folding and faulting of the Eocene-age sediments. Some of the faults locally control the contact between formations. The study area is located in a moderately active seismic region of southern California that is subject to significant hazards from moderate to large earthquakes. Ground shaking from major active and potentially active fault zones can affect the San Elijo Lagoon area in the event of an earthquake. The estimated peak horizontal ground acceleration for the maximum probable earthquake is approximately 0.45 gravitational force (g) from a magnitude 6.9 earthquake on the Rose Canyon fault zone, which occurs at a distance of approximately four kilometers (2.5 miles) from the study area. The peak horizontal ground acceleration for the design earthquake with a 10% probability of being exceeded in 50 years is 0.30 g. Impact of ground shaking on the lagoon would most likely affect the existing infrastructure, i.e. overpasses, bridges, dikes, and buried utilities. In addition to seismic shaking and its effect on engineered improvements within the lagoon, liquefaction of cohesionless soils can be caused by strong earthquake-induced ground motion. Research and historical data indicate that loose granular soils (with silt contents less than approximately 35% and clay contents less than approximately 20%) that are saturated by a relatively shallow groundwater table are most susceptible to liquefaction. Due to the presence of a shallow groundwater table and the relatively loose granular soils at the site, the potential for liquefaction is considered high. Sediment most likely to liquefy in the event of an earthquake would be within the upper 25-foot layer. Liquefaction could induce approximately 2 to 12 inches of settlement at the site. Effects of liquefaction would be highly variable across the site. In addition, lateral spreading (horizontal movement of soils) of on-site materials is possible in the event of a large seismic event.

FIGURE 2-2. ONSHORE GEOLOGIC FEATURES



2.4 Description of Reaches

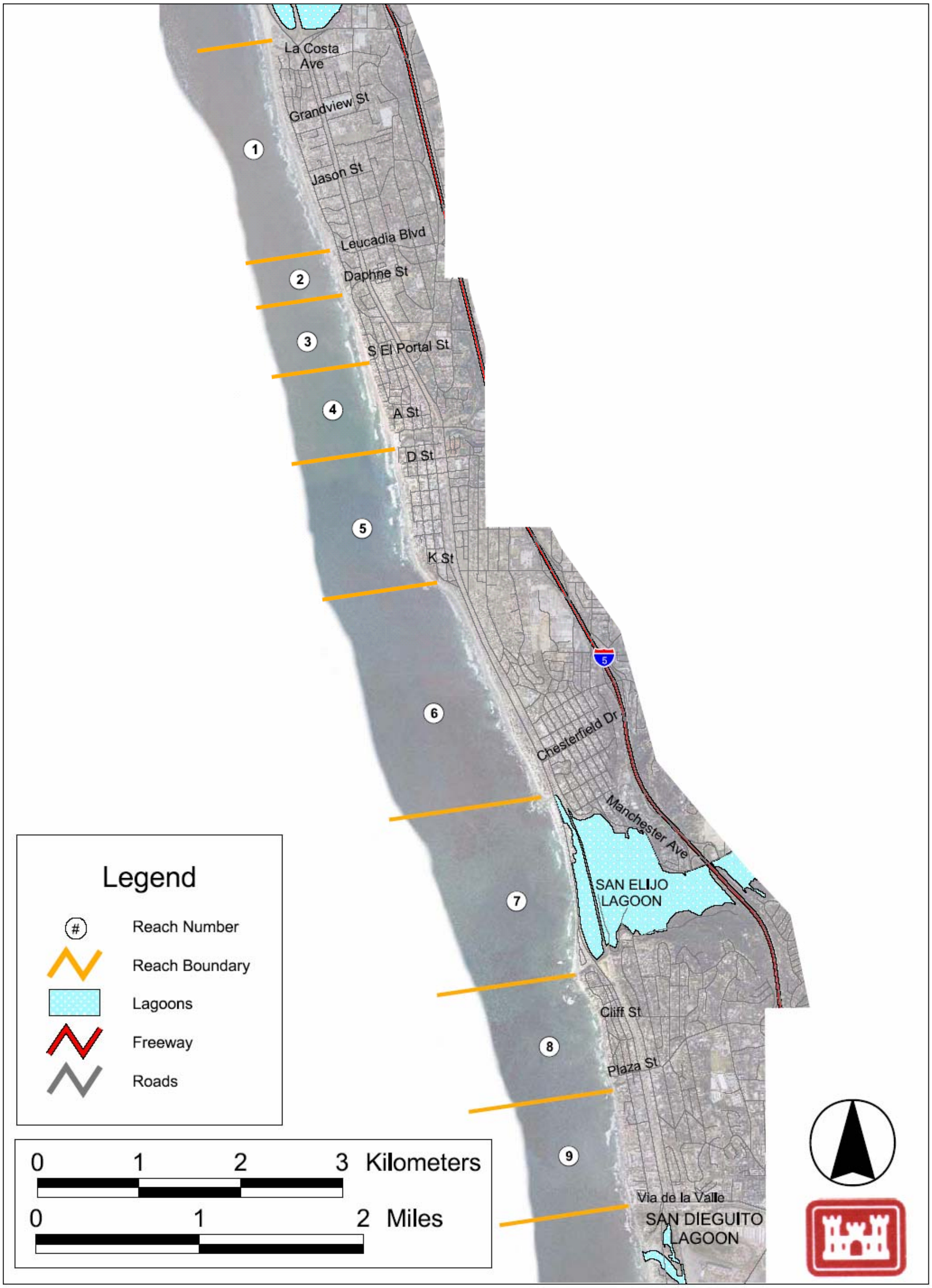
To better analyze the coastal bluff and shoreline morphology as well as oceanographic conditions, the entire Encinitas/Solana Beach study area was divided into nine reaches as illustrated below. The distinction between reaches is based on differences in seacliff geology, topography, coastal development and beach conditions. The locations and limits of each of the nine study reaches are shown in **Table 2-1**, and illustrated in **Figure 2-3**.

Beach conditions change seasonally, and the following reach descriptions may vary slightly over the year.

Table 2-1: Study Area Reaches

Reach	Range		Approx. Length (km)
	From	To	
1	Encinitas City Limit	Beacon's Beach	2.0
2	Beacon's Beach	700 Block, Neptune Ave.	0.5
3	700 Block, Neptune Ave.	Stone Steps	0.8
4	Stone Steps	Moonlight Beach	0.8
5	Moonlight Beach	Swami's	1.6
6	Swami's	San Elijo Lagoon Entrance	1.8
7	San Elijo Lagoon Entrance	Table Tops	1.9
8	Table Tops	Fletcher Cove	1.1
9	Fletcher Cove	Solana Beach City Limit	1.2

FIGURE 2-3. SOLANA BEACH-ENCINITAS STUDY AREA REACHES



2.4.1 Reach 1 – Encinitas Northern City Limit to Beacon's Beach

The northernmost shoreline segment between the Encinitas boundary and Beacon's Beach (**Figure 2-4**) is approximately 2.0 kilometers in length and can be characterized as having a narrow to medium sized beach backed by high seacliffs. For the study area, narrow to medium sized is defined as in the range of 50 – 150 feet width. For the study area, high cliffs are defined as approximately 50 feet and higher from toe to top. The bluff top is densely developed with residential structures varying from multiple-family residences to low-density private homes. Leucadia State Beach is located within Reach 1. Land use along the buffs is residential. Public parking areas are located at the northern and southern ends of Reach 1. A storm drain occurs at the beach at Grandview Street.

The seacliffs are relatively stable because of the erosional resistance of the bluff base, flatter upper bluff slope, vegetation cover and presence of a continuous protective cobble berm. After the 1997-1998 El Nino season, the extent of the existing protective cobble berm was diminished. The narrow beach has been temporarily widened as a result of sand nourishment placed at Leucadia in 2001 under SANDAG's Regional Beach Sand Project.

Small notches developed at the base of the bluff in the mid-1990s but have subsequently been covered over by a sand berm. Approximately 18% of the properties located along the bluff top have instituted the use of aesthetic seacliff toe protection measures in the form of privately constructed seawalls for seacliff toe protection.

FIGURE 2-4. REACH 1 PHOTOGRAPHS


Near Grandview Street, view south
(July 1999)


South of Grandview Street, view south
(June 2002)


Surfgrass at Grandview Beach
(May 2002)


Surfgrass near Beacon's Beach
(May 2002)


North of Beacon's Beach, view north
(June 2002)


Beacon's Beach, view north
(May 2002)

2.4.2 Reach 2 – Beacon's Beach to 700 Block, Neptune Avenue

The shoreline segment between Beacon's Beach and the 700 Block of Neptune Avenue (**Figure 2-5**) is approximately 0.5 kilometers (.3 miles) in length and includes two inactive ancient faults, namely the Beacons and Seawall Faults. The bluff top is densely developed with residential low-density private homes. Leucadia State Beach extends into Reach 2.

This reach can be characterized as having a narrow sandy beach backed by high, steep sea cliffs that consist of hard siltstone and claystone and extend approximately 25 to 30 meters (80 to 100 ft.) in height. The low bluff face of the southern section, south of 794 Neptune, is covered by a wide, thick zone of vegetation, extending approximately 12 to 18 meters (40 to 60 ft.) up from the bluff base.

The stability of the upper bluff is highly questionable along this portion of the reach as severe landslides are evident throughout. Several homes located along the bluff ledge have instituted emergency upper and lower bluff stabilization measures to protect against the catastrophic loss of the entire structure and to prevent the further erosion of the bluff base and the associated landslides that ensue as a result. In addition, several bluff top seaward facing decks extend beyond the ledge of recent bluff failures.

The beach was narrow after the 1982-1983 El Nino season as sand was stripped away and deposited too far offshore to return. As a result of the filled-sand dispersive effect, the sand replenishment from the SANDAG Regional Beach Sand Project at Leucadia has slightly widened the beach and formed a small protective berm at the bluff base. Within this reach, approximately one half of the properties are armored with a privately constructed seawall at the bluff base or a reinforced shotcrete wall on the upper bluff.

FIGURE 2-5. REACH 2 PHOTOGRAPHS

Between Leucadia Blvd. and Europa St., view south
(June 1999)

Near Europa St., view south
(May 1999)

South of Europa St., view west
(May 1999)

South of Europa St., view west
(July 1999)

Between Leucadia Blvd. and Europa St., view south
(June 2002)

South of Daphne St., view north
(June 2002)

2.4.3 Reach 3 – 700 Block, Neptune Avenue to Stone Steps

The shoreline segment between the 700 Block, Neptune Ave. and Stone Steps (**Figure 2-6**) is approximately 0.8 kilometers in length and can be characterized as possessing a narrow to medium beach backed by a high, steep sedimentary sandstone sea cliff, similar to that of Reaches 1 and 2. The bluff top is fully developed with residential homes along the entire length of this reach. This reach includes Encinitas Beach County Park.

The shore platform within this reach is lower than that at Reaches 1 and 2. Seacliffs are comprised of the slightly more erodible Santiago or Delmar Formations. There are several bluff failure areas and a wave cut notch, ranging from 1 to 2 meters (2 to 6 feet) deep, exists along the entire reach at the base of the bluff in areas where seawalls are absent. The upper bluff, comprised of weakly cemented sandstone, is oversteepened along much of this reach except intermittent sections where protective seawalls have been constructed along the bluff base and in areas where heavy vegetation throughout the bluff face is visible.

The beach width is much narrower here as compared to Reaches 1 and 2. As a result privately constructed seawalls have been instituted to protect the majority of the homes located along the edge of the bluff top. Along the northern section of the reach, a hybrid commixture of seawalls and upper bluff retention structures exist that are not particularly aesthetically sensitive. Some of these upper bluff stabilization techniques include shotcrete walls, as well as a terraced approach coupled with vegetation. Within the southern section (south of 560 Neptune Ave.), several sections of 4.5-meter high (15-foot) seawalls were constructed after 1996 when this area experienced severe bluff toe erosion.

FIGURE 2-6. REACH 3 PHOTOGRAPHS


South of Daphne St., view south
(June 1999)


Near Stone Steps, view south
(June 1999)


North of Stone Steps, view north
(May 1999)


North of Stone Steps, view north
(July 1999)


South of Daphne St., view south
(June 2002)


Near Stone Steps, view north
(June 2002)

2.4.4 Reach 4 – Stone Steps to Moonlight Beach

The shoreline section between Stone Steps and Moonlight Beach (**Figure 2-7**) is approximately 0.8 kilometers in length. Land uses in Reach 4 include Seaside Gardens Park and a parking area at the northern end of Moonlight State Beach. Adjacent land uses are primarily residential. Five storm drains occur at Moonlight Beach, three convey flows from Cottonwood Creek, and two are from residential neighborhoods.

Similar to the physical characteristics and urban development of Reaches 1 through 3, the narrow sandy beach along much of this reach is backed entirely by the more erodible Torrey Sandstone. The bluff top ranges in height from approximately 10 meters (30 feet) in the southern portion of the reach, adjacent to Moonlight Beach, and quickly transitions to approximately 25 to 30 meters (80 to 100 feet). Along the entire reach, except for the southern portion of the reach immediately adjacent to Moonlight Beach, an approximate 2 to 4-foot notch exists at the base of the bluff where notch protection measures have not been instituted. The prevalent notch development coupled with the already oversteepened upper bluff zone increases the probability of future bluff failures, some of which could be catastrophic. It was along this coastal segment where a bluff failure resulted in the loss of a human life in 2000.

Within the northern section, two small sections of bluff base are armored with seawalls that were constructed after 1996. Spotty notch fills are also used to protect the bluff base. However, some of the notch fills have been compromised as the bluff has since eroded out from behind them. Within the southern portion adjacent to Moonlight Beach, two patches of non-engineered revetment, probably constructed after the 1982-1983 El Nino season, protect the bluff toe from eroding.

The beach conditions are narrow on the northern portion and gradually widen toward Moonlight Beach. The sandy pocket beach that delineates Moonlight Beach is backed by a floodplain that gradually transitions into a cliff formation. Recreational facilities such as a lifeguard building and restrooms are located within the floodplain. The low lying plain and the associated beach width within Moonlight Beach is highly subject to wave attack particularly in response to large storm events. During these events, the back beach is subject to flooding and structures are susceptible to damage, as was the case during the winter of 1982-83. As a mitigation measure, the City constructs a protective temporary berm annually during the winter months to prevent flooding and potential damage to the City's facilities. This berm is built approximately 3 meters (10 feet) high on the back beach area to protect the recreational facilities there from inundation during large wave/storm events. There are no set dimensions, but the berm is usually about 600 feet (215 meters) long.

FIGURE 2-7. REACH 4 PHOTOGRAPHS

North of Moonlight Beach, view north
(May 1999)

North of Moonlight Beach, view south
(June 2002)

North of Moonlight Beach, view south
(June 2002)

View of north end of Reach 4, view north
(June 2002)

2.4.5 Reach 5 – Moonlight Beach to Swami's

The shoreline segment extending from Moonlight Beach to Swami's (**Figure 2-8**) is approximately 1.6 kilometers in length and contains a narrow to nonexistent sandy beach with a very thin sand lens backed by the predominant high, steep sea cliffs representative of the Encinitas shoreline. The development along the bluff top consists of high-density residential structures and the Self Realization Fellowship (SRF) property (Swami's) is located at the southern boundary of the reach. Two parks on the bluffs, H Street and I Street Viewpoint Parks, provide public access and viewing areas on the bluffs.

The bluff ranges in height from approximately 10 to 25 meters (30 to 80 feet) and is comprised of different formations. The northern one-third section is comprised of Torrey Sandstone, while the remaining section is comprised of the Del Mar formation, which is slightly more resistant to wave abrasion. The upper most sedimentary formations are comprised of a poorly consolidated siltstone to sandstone that is weakly cemented. This formation has a sloped face as it typically becomes highly unstable at vertical angles. In addition, groundwater percolates through the porous upper weakly cemented sandstone and then flows along the contact between the more resistant Del Mar formation. Evidence of groundwater seepage is prevalent along the low-lying rock face from approximately E Street south.

Historically, the beach within this reach is narrow and low in elevation. Even after the SANDAG Beach Sand Project was completed in 2001, the beach was still in the denuded condition. Only several small patches of cobble berm exist in certain sections of the reach. As a result, wave and tidally induced notching exist at the base of the bluff as the toe of the cliff is frequently exposed to seawater. In certain specific locations these notches are rather large, extending as deep as 2.5 or more meters (8 feet) and ranging in height from approximately 3 to 4.5 meters (10 to 15 feet). Essentially, these large notches form seacaves that are often large enough to crawl, and sometimes walk, into. Due to the deteriorated nature of the bluff face along this reach, numerous bluff top failures have occurred in the last few years.

No recent bluff toe protective devices have been constructed within this reach; however, a long revetment structure section is present at the Self Realization Fellowship (SRF) property providing additional bluff slope protection. The bluff at the SRF has had a long history of slope stability issues, as the area is highly susceptible to landslides. In fact, following the severe winter of 1941, the original SRF Temple, which had been built 10 meters (30 feet) from the edge of the cliff, collapsed onto the beach below as a result of a massive landslide (Kuhn and Shepard, 1984).

FIGURE 2-8. REACH 5 PHOTOGRAPHS

Moonlight Beach, view south
(May 1999)

South of Moonlight Beach, view northeast
(June 2002)

Near G Street, view west
(May 2002)

Near J Street, view southwest
(May 2002)

South of Moonlight Beach, view northeast
(June 2002)

Near K Street, view south
(June 2002)

2.4.6 Reach 6 – Swami's to San Elijo Lagoon Entrance

The shoreline segment between Swami's and San Elijo Lagoon (**Figure 2-9**) is approximately 1.8 kilometers in length and can be characterized by its narrow beach, varying presence of cobble, decreasing lower bluff topography, and relatively low development density. Reach 6 includes San Elijo State Beach and Cardiff State Beach. Adjacent land uses include park areas at Seacliff Park and San Elijo State Beach. These parks provide parking and visitor facilities such as restrooms and picnic tables. A 171-unit campground is located adjacent to the beach at San Elijo State Beach. Two storm drains occur at Swami's Beach, one pipe drains between Swami's and San Elijo State Beach, and one pipe drains at the north end of the State Beach.

Although a small number of private homes occupy the northern end, most of the reach segment contains the Highway 101 right-of-way and the San Elijo State Park, which includes recreational campsites and associated infrastructure.

The narrow beach is backed by cliffs ranging in height from approximately 20 to 25 meters (60 to 80 feet) in the northern portion of the reach dropping down to only a meter (or a few feet) at the Lagoon entrance. The sea cliffs within this reach are in varying states of stability. The lower portion of the cliffs are comprised of the Del Mar Formation and groundwater seeps and springs are common, particularly in the northern and middle section of the cliffs near Sea Cliff County Park that appear to be associated with greatly decreased slope stability. In fact, a 91-meter (300-foot) length of Highway 101 failed along this section in 1958 and was subsequently stabilized with improved drainage. In addition, a rock revetment embankment was installed to protect the highway from future storm and tidal impacts in 1961. The southern portion of the reach is backed by the San Elijo State Beach Campground and contains non-engineered riprap that protects five beach access points.

FIGURE 2-9. REACH 6 PHOTOGRAPHS

Swami's, view south
(June 2002)

North end of Reach 6, view east
(June 2002)

South of Swami's, view north
(May 2002)

Swami's, view southeast
(May 2002)

San Elijo State Beach, west northeast
(May 2002)

San Elijo State Beach, view west
(May 2002)

2.4.7 Reach 7 – San Elijo Lagoon to Table Tops

The low lying shoreline segment extending from San Elijo Lagoon to Table Tops (**Figure 2-10**) is approximately 1.9 kilometers in length and essentially forms a sand barrier between the Pacific Ocean and the San Elijo Lagoon. Development within this reach consists of three popular restaurants (The Chart House, Charlie Browns, and Sunsets), at the northern end of the reach with vehicular parking and highway right-of-way sections comprising the majority of improvements over the remaining portions of the reach. Reach 7 includes Cardiff State Beach. Cardiff State Beach includes parking lots and visitor facilities at the north and south ends of the beach. Restaurant Row is adjacent to the beach at the north end of Reach 7, south of the opening to San Elijo Lagoon.

This reach consists of a narrow sandy and cobble spit beach backed by Highway 101, which is protected by a non-engineered (random selection and placement) rock and concrete rubble revetment.

The combination of natural and artificial shoreline protection along this reach results in reduced exposure to storm-induced wave damage and flooding. However, the close proximity of the restaurants located in the northern section of the reach, to the water's edge has rendered, and will continue to render them susceptible to periodic episodes of incidental inundation and structural damage. Moreover, severe storms also cause flooding along Highway 101. For the most part, this is limited to only partial lane closures for limited time periods; however, the most severe storm occurrences often result in complete road closure for several days due to both coastal flooding and the time required to remove debris from the roadway.

FIGURE 2-10. REACH 7 PHOTOGRAPHS

North of restaurants, view north
(May 1999)

South of restaurants, view north
(May 1999)

Near San Elijo Lagoon entrance, Cardiff reef,
view northeast (May 2002)

Cardiff reef, view west
(May 2002)

Near San Elijo Lagoon entrance, view south
(June 2002)

Middle of Reach 7, view east
(June 2002)

2.4.8 Reach 8 – Table Tops to Fletcher Cove

The shoreline segment between Table Tops and Fletcher Cove (**Figure 2-11**) is approximately 1.1 kilometers in length and represents the northern reach located in the City of Solana Beach. The bluff top is fully developed throughout the reach with large multi-story private residences. Reach 8 includes Tide Beach Park and the parking area for Fletcher Cove Beach Park. The cliffs are approximately 22 meters (70 feet) high and are comprised of Torrey Sandstone over the lower 3 to 4.5 meters (10 to 15 feet) of the cliff face with the remaining 20 meters (63 feet) comprised of poorly consolidated silty sandstone.

The shoreline may be characterized as consisting presently of a narrow to non-existent sandy beach backed by high, wave cut cliffs. In addition, small pockets of cobble exist in the back beach area at various locations. Fletcher Cove is located at the southern boundary of this reach and represents a small pocket beach with good public access. Prior to the 1997-1998 El Nino season, the moderate beach condition provided a buffer in preventing the bluff face from being directly exposed to storm wave attack and, as a result, only limited bluff erosion was reported. During the 1997-1998 winter months, sand was stripped away and the bluff face became directly exposed to wave abrasion. Severe toe erosion subsequently developed and bluff failures have been continuously reported since. Presently, notches, on the order of 1.3 to 2.4 meters (4 to 8 feet), and large seacaves exist throughout the lower bluff region.

Several bluff top residences have instituted lower bluff stabilization measures to protect against the impingement of waves and tides. These stabilization measures include concrete seawalls, some of which have employed the use of textured artistic surfaces to appear more realistic, ranging in height from one meter (or a few feet) to approximately 4.5 meters (15 feet), as well as concrete notch infills designed to fill in the voids created by the abrasive forces of waves and tides. However, at several notch infill locations, erosion has since taken place in the lee of the infill resulting in the seepage of bluff sediment around the end of the infill. The existing notching at the base of the bluff, when combined with the already over steepened upper bluff, is indicative of potentially catastrophic block failures.

FIGURE 2-11. REACH 8 PHOTOGRAPHS

Table Tops reef, view northwest
(July 1999)

Table Tops reef, view south
(May 2002)

Tide Park reef, view west
(May 1999)

Tide Park, view east
(June 2002)

Pill Box reef, view west
(June 1999)

North of Fletcher Park, view east
(June 2002)

2.4.9 Reach 9 – Fletcher Cove to Solana Beach Southern City Boundary

The shoreline segment between Fletcher Cove and the southern boundary of Solana Beach (**Figure 2-12**) is approximately 1.2 kilometers in length. The bluff top, ranging in height from approximately 20 to 25 meters (62 to 80 feet), is fully developed with private residential houses, as well as multiple family town homes and condominiums. Reach 9 includes Fletcher Cove Beach Park and North Seascape Surf Beach Park. Residential development occupies the top of the bluffs. One storm drain occurs at Fletcher Cove and another drain occurs at Seascape. The seacliffs are comprised of an erosive Torrey Sandstone lower bluff and a weakly consolidated sandstone layer throughout the remaining upper portions of the bluff, which are prone to both sliding and block failure.

The shoreline within this reach can presently be characterized as consisting of a narrow to non-existent sandy beach backed by high, steep sea cliffs. Various small pockets of natural cobble berm exist in the southern half of the reach that provides limited protection to the bluff face. Similar to those of Reach 8, the bluffs within this reach are also susceptible to the repeated exposure of waves and tides after the 1997-1998 El Nino season during which time the beach was denuded. The developed notches range in depth from approximately 0.7 to 2.6 meters (2 to 8 feet) and fractures that extend through the upper bluff are evident above, and adjacent to, the deeper notches. Evidence of several landslides exist within the reach and a recent large block failure in the center of the reach had occurred just prior to a field investigation conducted on February 6, 2002. Seacaves, several of which extend as deep as 6 to 10 meters (18 to 30 feet), are present in several areas near the southern portion.

Several locations have instituted stabilization measures in the form of seawalls, rock revetments, and notch infills to protect the base of the bluff from eroding. However, the cliff face in the lee of older constructed notch infills and plugs has since eroded leaving the notch infill intact in its original position while the bluff face continues to erode from behind it. In places this has been measured to be as much as 1 to 1.2 meters (3 to 4 feet). This is indicative of the fairly aggressive erosive nature of the base of the bluff in this shoreline segment of the study area.

It is apparent that without corrective action, this reach will continue to have episodic landslides and block failures. The beach provides almost no buffer zone between wave and tidal impacts and the base of the bluff, and as a result, the bluff face bears the full brunt of this energy. In fact, the bluff toe is exposed even during mid-tide levels, which is exacerbated further during storm events. This repeated exposure has resulted in the continued erosion of the bluff face and the associated recession of the upper bluff. It is expected that without corrective action, the magnitude of the upper bluff recession will most likely accelerate in this reach until the upper bluffs have fully equilibrated with the ongoing erosion occurring at the base of the bluff.

FIGURE 2-12. REACH 9 PHOTOGRAPHS

Mid Reach 9, view north
(July 1999)

Mid Reach 9, view south
(July 1999)

Mid Reach 9, view north
(May 2002)

Near south end Reach 9, view south
(July 1999)

Near south end Reach 9, view east
(June 2002)

South end of Reach 9, view southeast
(June 2002)

2.5 Oceanographic Processes

The most critical factors in wave-induced shoreline erosion are water level and wave height, which are determined by oceanographic processes. Water levels within the surf zone consist of four primary factors:

1) local weather and climatic variation related to cyclical patterns,
2) astronomical tides,
3) Storm induced waves, including surge, setup and direction and
4) long-term changes in sea level.

Each of these factors is briefly described in the following sections (more detailed descriptions of coastal parameters, calculations, discussion of methodologies, and relevant tables are presented in the Coastal Engineering Appendix).

2.5.1 Climatic Conditions

The Encinitas and Solana Beach coastal region has a semi-arid Mediterranean type climate that is maintained through relatively mild sea breezes over the cool waters of the California current. Winters are usually mild with rainfall totals around the coast averaging approximately 25 to 50 centimeters (10 to 20 inches) per year. The rainfall increases in the inland areas ranging from approximately 50 (20) to, as much as, 150 (60) inches per year in the coastal mountains. **Table 2-2** presents the climate summary at an adjacent station (Station Number 046377 at Oceanside Marina).

Table 2-2. Monthly Climatic Summary at Oceanside Marina

Month	Ave. Max. Temperature C^{O} (F^{O})	Ave. Min. Temperature C^{O} (F^{O})	Ave. Total Precipitation cm (in)
Jan	17.1 (63.9)	6.9 (44.5)	5.5 (2.18)
Feb	17.7 (64.0)	5.7 (47.6)	5.0 (1.98)
Mar	17.7 (64.0)	8.2 (47.4)	4.6 (1.83)
Apr	18.6 (65.4)	10.2 (50.3)	2.4 (0.96)
May	19.3 (66.8)	12.6 (54.7)	0.6 (0.22)
Jun	20.4 (68.7)	14.6 (58.2)	0.2 (0.09)
Jul	22.5 (72.5)	16.7 (62.1)	0.08 (0.03)
Aug	23.6 (74.50	17.4 (63.3)	0.2 (0.08)
Sep	23.4 (74.1)	16.0 (60.9)	0.7 (0.28)
Oct	22.1 (71.8)	13.2 (55.7)	0.8 (0.30)
Nov	20.2 (68.3)	9.3 (48.8)	2.8 (1.10)
Dec	18.4 (65.1)	7.0 (44.6)	3.2 (1.24)

Typically, the wind climate in the offshore area within 60 to 160 kilometers (50 to 100 miles) of Encinitas and Solana Beach is characterized by northwesterly winds averaging between 16 to 48 kilometers (10 to 30 miles) per hour. The predominant winds within the coastal region during October through February are from the east-northeasterly direction, while the winds during March through September are from the west-northwesterly direction. Average wind velocities during the summer and winter months along the coast range approximately between 8 and 11.2 kilometers (5 and 7 miles) per hour, respectively. Exceptions in the wind speed and direction occur during occasional winter storms in which wind direction may vary and during Santa Ana conditions when winds are usually strong out of the northeast.

Southern Oscillation El Nino (SOEN) Events

Southern Oscillation El Nino (SOEN) events are global-scale climatic variations with a duration lasting for approximately 2 to 7 years. They represent an oscillatory exchange of atmospheric mass as manifest by a decrease in sea surface pressure in the eastern tropical Pacific Ocean, a decrease in the easterly trade winds, and an increase in sea level on the west coast of North and South America (USACOE-LAD, 1986). The interaction between the atmospheric and oceanic environment during these events drive climatic changes that can result in significant modifications of wave climate along the world's coasts.

The severe winter seasons of 1982-1983 and 1997-1998, which produced some of the most severe storms to ever impact the Encinitas and Solana Beach coast, were the result of intense SOEN events. The atmospheric disturbance associated with these two events caused abnormally warm water temperatures, an actual reversal of the westerly trade winds, and increased the monthly mean sea levels by as much as 0.13 meters (0.42 feet) in 1982-1983 season and 0.16 meters (0.52 feet) in 1997-1998 season at La Jolla, San Diego (Flick, 1998).

Long Term Climatic History

Historically, the climate in Southern California alternates in cycles between benign and severe conditions. For example, the cyclic drought climate observed in the early 1970's was followed by a severe stormy weather period in the late 1970's and early 1980's including the 1983 El Nino season. It is well known that a significant correlation does exist between the El Nino events and the occurrence of severe weather patterns involving larger storm waves along the coast of Southern California. In the past 50 years, the increase of more vigorous winter cyclones in North Pacific (Graham & Diaz, 2001) may be attributed to the observed modulation of El Nino events with steady repetitive occurrences. Due to the continuous trend of global warming, the intensity of each El Nino event and associated winter storms in Southern California is likely to increase. Consequently, the cyclic benign (draught) and severe (wet) weather patterns will be more intensified in the future as the acceleration of global warming continues.

2.5.2 Tides

Tides along the Southern California coastline are of the mixed semi-diurnal type. Typically, a lunar day (about 24 hours) consists of two high and two low tides, each of different magnitudes. A lower low tide normally follows the higher high tide by approximately seven to eight hours while the time to return to the next higher high tide (through higher low and lower high water levels) is usually approximately 17 hours. Annual tidal peaks typically occur during the summer and winter seasons. The increased tidal elevations during the winter season can exacerbate the coastal impacts of winter storms.

Since tides have a spatial scale on the order of hundreds of miles, the prevailing tidal characteristics measured in La Jolla may be considered representative of the tidal elevations within the project area. The National Oceanic and Atmospheric Administration (NOAA) has established tidal datum for La Jolla in San Diego County based on 18 years of collected measurements from the 1960 through 1978 tidal epoch. The tidal characteristics at the La Jolla tidal station, referenced to the Mean Lower Low Water (MLLW) vertical datum are presented in **Table 2-3**. The highest recorded sea level at the La Jolla gage located at the terminus of the Scripps Pier was 2.38 meters (7.81 feet), MLLW measured on August 8, 1993.

Table 2-3. Tidal Characteristics at Scripps Pier in La Jolla, California (San Diego County)

Datum Plane	**Elevation, meters (feet) MLLW**

Highest observed water level (Aug. 8, 1993)	+2.38 (+7.81)
Mean Higher High Water (MHHW)	+1.64 (+5.37)
Mean High Water (MHW)	1.41 (+4.62)
Mean Tide Level (MTL)	0.84 (+2.77)
Mean Sea Level (MSL)	0.84 (+2.75)
National Geodetic Datum – 1929 (NGVD)	0.78 (+2.56)
Mean Low Water (MLW)	0.28 (+0.93)
Mean Lower Low Water (MLLW)	0.00 (0.00)
Lowest observed water level (Dec. 17, 1933)	-0.80 (-2.60)
Source: USACOE-LAD, 1994	

2.5.3 Waves

2.5.3.1 Surge and Setup

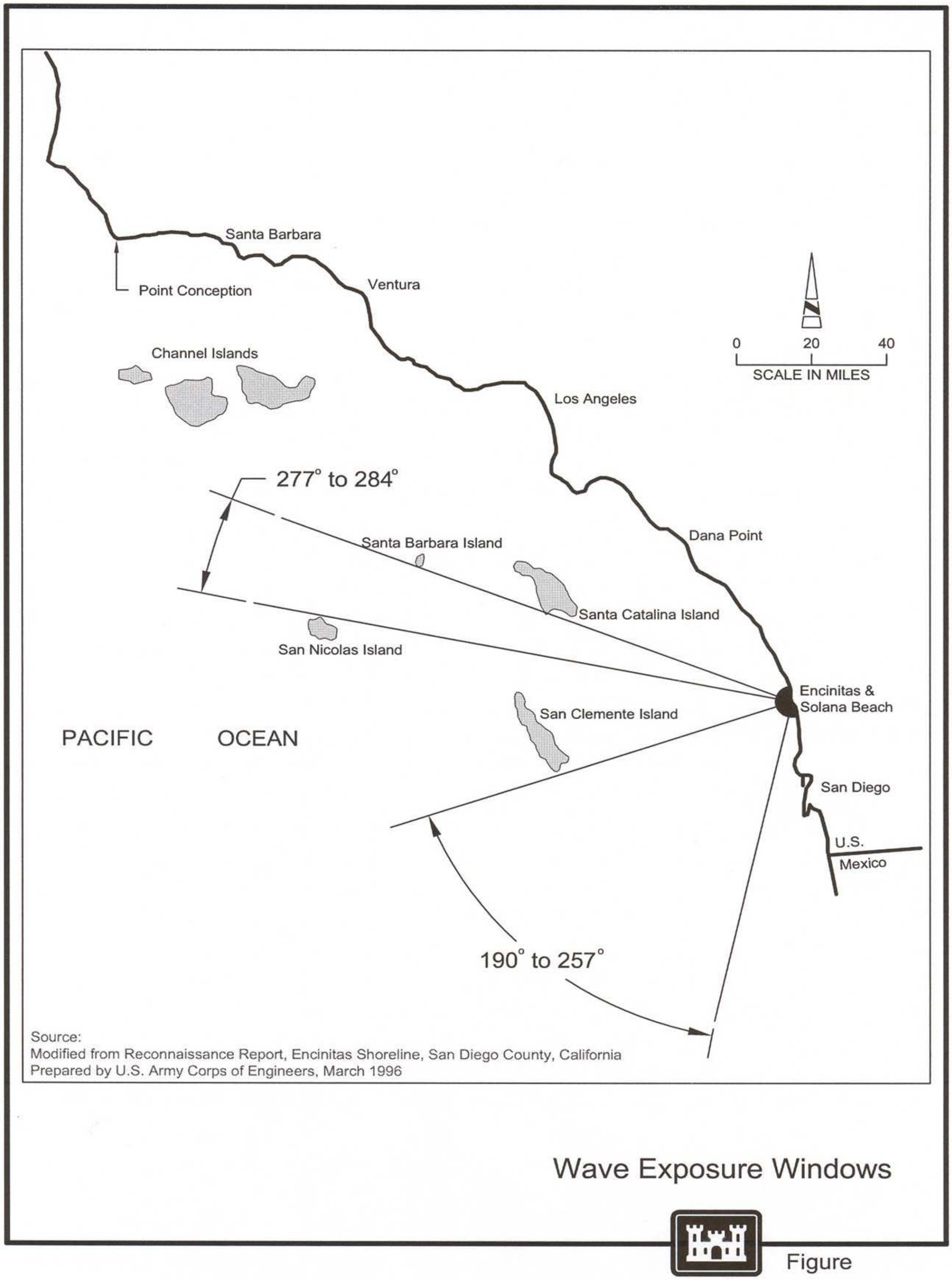
Storm surge results from storms that induce fluctuations in the wind speed and atmospheric pressure. Storm surge is usually fairly small on the west coast of the United States when compared to water level increases resulting from storm surge on the east coast. The decreased impact of storm surge on the west coast is due primarily to the relatively narrow continental shelf. It was estimated that the average increase in the water level resulting from storm surge effects ranges from approximately 0.09 to 0.15 meters (0.3 to 0.5 feet) within the San Diego coastal zone (USACOE, 1991). The average positive tide residual event usually occurs in a temporal scale of approximately six days; however, storm surges of significant magnitudes rarely continue for longer than two days.

Wave setup is the super-elevation of wave levels and occurs primarily in the surf zone where waves break as they approach a beach and reach their limiting wave steepness. The magnitude of the wave setup depends on the height of breaking waves occurring in the surf zone. The elevated wave levels increase the magnitude of waves impinging onto the seacliff face during a storm event. Waves that impinge on the shoreline, perhaps more than any other oceanographic factor, determine the fate of sediment movement and the associated impacts to the coastal environment. Essentially, waves are the driving force in generating the alongshore currents that are responsible for moving sand, suspended by wave action, along the coast, which ultimately results in changes to the shoreline. This section describes the regional wave climate within Encinitas and Solana Beach region.

2.5.3.2 Wave Origin and Exposure

Given that the predominant weather trend in the Pacific Ocean is from northwest to southeast, there is a sufficient fetch for storms to generate substantial waves with periods averaging between 10 and 20 seconds. The fetch is defined as a region in which the wind speed and direction are reasonably constant. If storms occur closer to the coastline, the waves are considered to be locally generated and have periods much shorter than the 10 to 20 second period typically associated with swell events.
Wind waves and swell within the project study area are produced by six basic meteorological weather patterns. These include extratropical storm swells in the northern hemisphere (north or northwest swell), wind swells generated by northwest winds in the outer coastal waters (wind swell), westerly (west sea) and southeasterly (southeast sea) local seas, storm swells of tropical storms and hurricanes off the Mexican coast, and southerly swells originating in the southern hemisphere (southerly swell). **Figure 2-13** illustrates the wave exposure windows associated with the identified weather patterns.

FIGURE 2-13. WAVE EXPOSURE FOR THE SAN DIEGO REGION



Numerous storms have impacted the Southern California Coast in the past. The storms adversely impacting the project study area mainly are a result of extratropical winter events that, when combined with spring high tides, can cause severe beach and bluff erosion. The 1982-1983 El Nino winter storms resulted in permanent beach sand loss within the Encinitas coast that subsequently had a detrimental impact to the bluff stability as seacliffs become directly exposed to storm wave attack. Accelerated toe erosion occurred at the bluff face in Solana Beach after limited beach sand was completely stripped away during the 1997-1998 El Nino stormy season.

Extreme storm events were selected primarily on the basis of their potential to generate damaging waves to the Encinitas and Solana Beach coast. This placed the emphasis on long period swells approaching from their respective exposure windows, dictated in large part by the offshore islands. Deepwater wave characteristics of extreme storm conditions have been hindcasted and measured in deep water. Pertinent hindcasted extratropical storm waves in deep water were selected to characterize the extreme deep ocean wave conditions, as presented in **Table 2-4**.

Table 2-4. Hindcasted Extreme Extratropical Deep Water Wave Characteristics

Date of Storm	**(m)**	**Ts (sec)**	**Dir (deg)**	**Date of Storm**	**Hs (m)**	**Ts (sec)**	**Dir (deg)**
12/31/79	5.30	16.9	286	3/1/91	5.00	12.7	277
2/17/80	5.44	12.7	254	2/11/92	4.51	12.7	269
2/20/80	6.52	15.3	265	1/18/93	4.39	10.5	241
1/22/81	5.55	16.9	277	2/9/93	4.34	15.3	277
1/29/81	5.90	12.7	275	1/5/95	5.53	8.7	288
12/1/82	6.80	12.7	298	1/11/95	5.04	13.9	280
1/27/83	6.98	15.3	287	2/3/95	4.29	16.9	278
2/13/83	5.91	16.9	278	3/12/95	5.89	15.3	273
3/2/83	9.23	16.9	270	2/1/96	4.22	10.5	257
12/3/85	5.68	15.3	286	12/7/97	4.03	9.5	229
2/1/86	5.40	16.9	282	1/30/98	6.61	16.9	287
2/16/86	7.53	16.9	258	2/1/98	5.15	16.9	279
3/11/86	6.78	16.9	286	2/4/98	7.02	16.9	280
3/5/87	4.07	13.9	267	2/7/98	5.89	13.9	266
12/17/87	5.17	16.9	283	2/18/98	6.86	16.9	282
1/18/88	9.86	13.9	290	2/21/00	5.33	12.7	280
2/4/91	4.50	16.9	277				

Notes: Hs denotes significant wave height
Ts denotes wave period

2.5.3.4 Nearshore Wave Characteristics

Deepwater waves that enter the nearshore coastal area of the study region are altered by offshore island sheltering, refraction, diffraction, and shoaling effects as they propagate towards the shoreline. The offshore islands, as illustrated in Figure 2-14 provide some sheltering from waves approaching from the deep ocean. As waves continue to propagate shoreward, the combined effects of refraction and shoaling must be accounted for when determining the shallow water wave characteristics.

Transformation of deep ocean waves to the nearshore coastal area near the study site was performed using a spectral back-refraction model (O'Reilly and Guza, 1991). The numerical model accounts for island blocking, wave refraction and wave shoaling. **Table 2-5** shows the transformed nearshore extreme wave characteristics at Cardiff (Reach 7). The representative nearshore station, where the hindcasted deepwater wave characteristics were transformed to, is at 33°0'30.5" N and 117°17'3.9"W in a water depth of approximately 9.91 meters (32.5 feet).

Table 2-5. Hindcasted Extreme Extratropical Nearshore Wave Characteristics At Reach 7

Date of Storm	Hs (m)	Ts (sec)	Dir (deg)	Date of Storm	Hs (m)	Ts (sec)	Dir (deg)
12/31/79	2.8	16.9	265	3/1/91	3.3	12.7	235
2/17/80	3.8	12.7	240	2/11/92	3.0	12.7	255
2/20/80	4.7	15.3	265	1/18/93	3.2	10.5	225
1/22/81	4.0	16.9	265	2/9/93	3.0	15.3	265
1/29/81	3.6	12.7	260	1/5/95	3.2	8.7	225
12/1/82	2.7	12.7	255	1/11/95	3.9	13.9	260
1/27/83	3.7	15.3	265	2/3/95	3.0	16.9	265
2/13/83	4.0	16.9	265	3/12/95	3.9	15.3	260
3/2/83	6.9	16.9	285	2/1/96	2.8	10.5	235
12/3/85	2.8	15.3	265	12/7/97	2.8	9.5	220
2/1/86	3.0	16.9	265	1/30/98	3.2	16.9	265
2/16/86	5.6	16.9	260	2/1/98	3.3	16.9	265
3/11/86	3.5	16.9	260	2/4/98	4.5	16.9	265
3/5/87	3.1	13.9	265	2/7/98	3.8	13.9	250
12/17/87	3.0	16.9	260	2/18/98	3.8	16.9	265
1/18/88	5.0	13.9	260	2/21/00	2.9	12.7	255
2/4/91	2.9	16.9	265				

Notes: Hs denotes significant wave height
Ts denotes wave period

2.5.3.5 Tsunamis

Tsunamis are long period waves caused by a large underwater disturbance such as an earthquake, volcanic eruption or landslide. Tsunamis cross the deep ocean as very long waves of low amplitude. Waves produced by tsunamis typically have a wavelength in excess of 160 kilometers (100 miles) with an amplitude of one meter (3 feet) or more. The waves resulting from a tsunami can be significantly amplified by shoaling, diffraction, refraction, convergence, and resonance as they propagate towards the coast, namely due to the immense traveling wave speeds and lengths.

Historically, no tsunami has ever significantly affected the Encinitas and Solana Beach coast. It is believed that local earthquake events will not produce underwater disturbances capable of generating tsunamis within this coastal region. Although historically tsunamis were originated off the coasts of Chile and Alaska, the propagation impacts to the Encinitas and Solana Beach have been negligible. Therefore, the threat of coastal flooding resulting from tsunamis along the Encinitas and Solana Beach coastal region is considered low.

2.5.4 Sea Level Rise

Although the exact magnitude of the future sea level rise is unknown, the main influencing factors are ocean water thermal expansion and the meltwater from continental glaciers and the Antarctic ice sheet. The proportion of each contribution depends largely upon the actual global distribution of temperature increases, the resulting precipitation amounts, the glacial response and dynamics, the time scale of oceanic mixing, and the stability of the west Antarctic ice sheet (USACOE-LAD, 1991). The present best estimates regarding sea level rise within Southern California vary between 0.03 to 0.06 meters (0.1 and 0.2 feet) in a time span of 25 years (Collins, 1993 and USACOE-LAD, 1991). This correlates to an approximate 0.12 to 0.24 meters (0.4 to 0.8 feet) potential increase in mean sea level elevations over the course of the next century. It is important to note that the main effect of the slow global sea level rise will be to worsen the consequences of each successive SOEN event and the associated storm induced impacts.

2.5.5 Currents

This section details the coastal and oceanographic currents affecting the water circulation patterns within the Encinitas and Solana Beach area. These include offshore currents (currents existing offshore of the project area), alongshore currents (currents flowing parallel to the shoreline), and cross-shore currents (currents flowing perpendicular to the shoreline).

2.5.5.1 Offshore Currents

The offshore currents, including the California Current, the California Undercurrent, the Davidson Current, and the Southern California Countercurrent (also known as the Southern California Eddy), consist of major large-scale coastal currents, constituting the mean seasonal oceanic circulation with induced tidal and event specific fluctuations on a temporal scale of 3 to 10 days (Hickey, 1979).

The California Current: The California Current is the southern flow of water off the coast and is characterized as a wide, sluggish body of water that has relatively low levels of temperature and salinity. Peak currents with a mean speed of approximately 12.5 to 25 centimeters per second occur in summer after several months of persistent northwesterly winds (Schwartzlose and Reid, 1972).

The California Undercurrent: The California Undercurrent is a subsurface northward flow that occurs below the main pycnocline and seaward of the continental shelf. The mean speeds are low, on the order of 5 to 10 centimeters per second (Schwartzlose and Reid, 1972).

The Davidson Current: The Davidson Current is a northward flowing nearshore current that is associated with winter wind patterns north of Point Conception. The current, which has average velocities between

15 and 30 centimeters per second, is typically found off the California coast from mid-November to mid-February, when southerly winds occur along the coast (Schwartzlose and Reid, 1972).

The Southern California Countercurrent: The Southern California Countercurrent is the inshore part of a large semi-permanent eddy rotating cyclonically in the Southern California Bight south of Point Conception. Maximum velocities during the winter months have been observed to be as high as 35 to 40 centimeters per second (Maloney and Chan, 1974).

2.5.5.2 Alongshore Currents

Alongshore Currents are those nearshore currents that travel parallel to the shoreline extending throughout, and slightly seaward of, the surf zone. The alongshore current in the coastal zone are driven primarily by waves impinging on the shoreline at oblique angles. The rate of alongshore sediment transport varies in proportion to characteristics of the regional wave climate and the directional predominance. The surf zone alongshore currents within the project area are nearly balanced between northerly and southerly flows and can attain maximum velocities of approximately one meter per second. Typically, summer swell conditions produce northerly drifting currents, while the large winter storms from the west and northwest produce southerly alongshore currents. Overall, the persistence of the northerly drift occurs more frequently; but the alongshore wave energy associated with the winter storms generally results in a net southerly littoral drift (CCSTWS, 1990).

2.5.5.3 Cross-shore Currents

Cross-shore currents exist throughout the study area, particularly at times of increased wave activity. These currents tend to concentrate at creek mouths and structures, but can occur anywhere along the shoreline in the form of rip currents and return flows of complex circulation. To date, no information is available that quantifies the velocities of these currents within the project area; however, studies have shown that the velocity of rip currents, in general, can exceed 2 meters per second (Dean and Dalrymple, 1999).

2.6 Littoral Processes

2.6.1 Technical Background

The net rate of sand supply to a beach is one of the most important factors in determining the health of that beach. The influx of sediment to the beach represents one element of the local sand budget while the loss of sediment represents the other. The difference between these two flows determines whether a beach increases or decreases in width. Identifying the littoral processes and determining a realistic sediment budget for the project study locale requires an understanding of the quantification of sediment sources, sinks, and transport characteristics, the quantification and interpretation of past shoreline changes, as well as the shoreline response to artificial beach nourishment activities. Knowing where the regional sand supply sources are and quantifying the contribution of each source is critical in fully understanding beach erosion issues so that viable strategic alternatives can be formulated and designed to alleviate them.

The littoral cell is one of the most important concepts to utilize when analyzing the littoral processes of a coastal region. A littoral cell is a control volume defined as a geographically limited coastal compartment containing sand inputs, sand outputs, and sand transport paths. Ideally, cells are isolated from each other to ensure no exchange of sediment in either the upcoast or downcoast direction; thereby, simplifying the tracking of sand movement. However, in reality some sediment is typically transported between upcoast and downcoast cells. Where this occurs, it is important to quantify the net transport volume bypassed between adjacent cells.

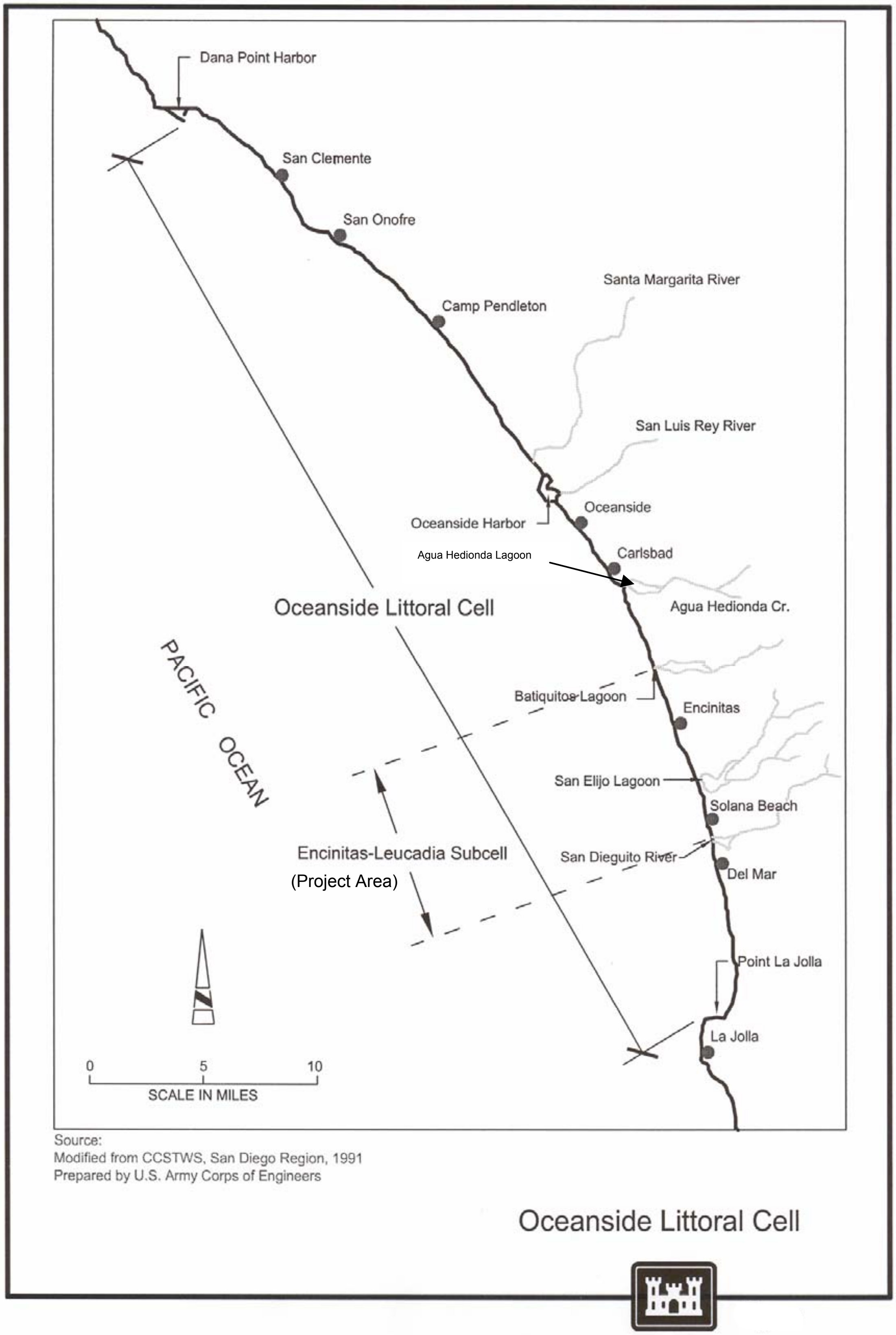
2.6.2 Oceanside Littoral Cell / Encinitas – Leucadia Subcell

The coastal zone of the project study area is located within the Encinitas – Leucadia subcell of the Oceanside Littoral Cell, which extends approximately 12 kilometers (7.5 miles) from the south jetty of the Batiquitos Lagoon entrance to the southern boundary of the City of Solana Beach, as illustrated in **Figure 2-14**. The encompassing Oceanside Littoral Cell is an 82-kilometer (51-mile) long coastal reach bounded on the north by Dana Point Harbor and the south by Pt. La Jolla. This littoral cell contains a wide variety of coastal features including coastal cliffs, headlands, beaches composed of sand and/or cobblestone, rivers, creeks, tidal lagoons and marshes, submarine canyons, man-made shore and bluff protection devices, and major harbor structures. Within the Encinitas-Leucadia subcell, the shoreline is mostly characterized as consisting of narrow sandy beaches backed by high seacliffs. During the past 20 years or so, the backshore and bluff tops of this subcell have experienced rapid residential and commercial development and artificial beach nourishment has been performed periodically at many locations as well.

Seasonal variations in beach width are typical within the Encinitas-Leucadia subcell. During the winter season, when the wave environment is energetic, sediment is transported from the beach area and is stored in an offshore bar formation. These sands then return to the beach throughout the summer when a more benign wave environment is present. During the Coast of California Storm and Tidal Waves Study for the San Diego County Region (CCSTWS-SD), beach profile data (USACOE-LAD, 1991) indicated that the beaches experienced seasonal winter erosion in excess of 30.5 meters (100 feet). A loss of beach width of this magnitude, when combined with the already narrow beaches, has led to the seasonal disappearance of many of the sandy beaches within this subcell.

Historically, the net alongshore sediment transport in this region has been considered to be from north to south; however, recent increased wave activity from the south over the past 10 to 15 years has resulted in an increase in the northerly littoral transport, as compared with previous decades, thus decreasing the net flow of southerly littoral transport materials.

FIGURE 2-14. OCEANSIDE LITTORAL CELL



2.6.3 Shoreline Change-Beach Morphology

Littoral Processes are what determine the changes in beach profiles, therefore, shoreline morphology is best analyzed in terms of the sediment budget. The following presents a summary of the major littoral modes and mechanisms in the study area. More detailed analysis of the sediment budget can be found in the Coastal Engineering Appendix. Evidence from historical ground and aerial photographs (USACOE-LAD, 1996, 2002) indicates that the beach conditions can be roughly divided into pre-1980 and post-1980 periods.

2.6.3.1 Early Years – Balanced Budget-Seasonal Variation

Prior to approximately 1980, the shoreline experienced cyclical advance and retreat. The beaches would naturally retreat during rough weather years when the beach sands were carried offshore into deeper sandbars and/or transported out of the littoral subcell. In milder years and summer months, beaches would recover as this offshore sand gradually made its way back onshore under milder wave conditions. The beaches also received more fluvial sediment delivery and were occasionally replenished in the 1950s, 1960s and 1970s when sand from a series of beach nourishment projects conducted at Oceanside and Carlsbad was gradually transported downcoast to the Encinitas and Solana Beach region. Historically, the moderate beaches provided a buffer zone against waves directly impinging upon the bluff face. As a result, little bluff toe erosion occurred prior to the 1980s.

2.6.3.2 Later Years – Deficit and Retreat

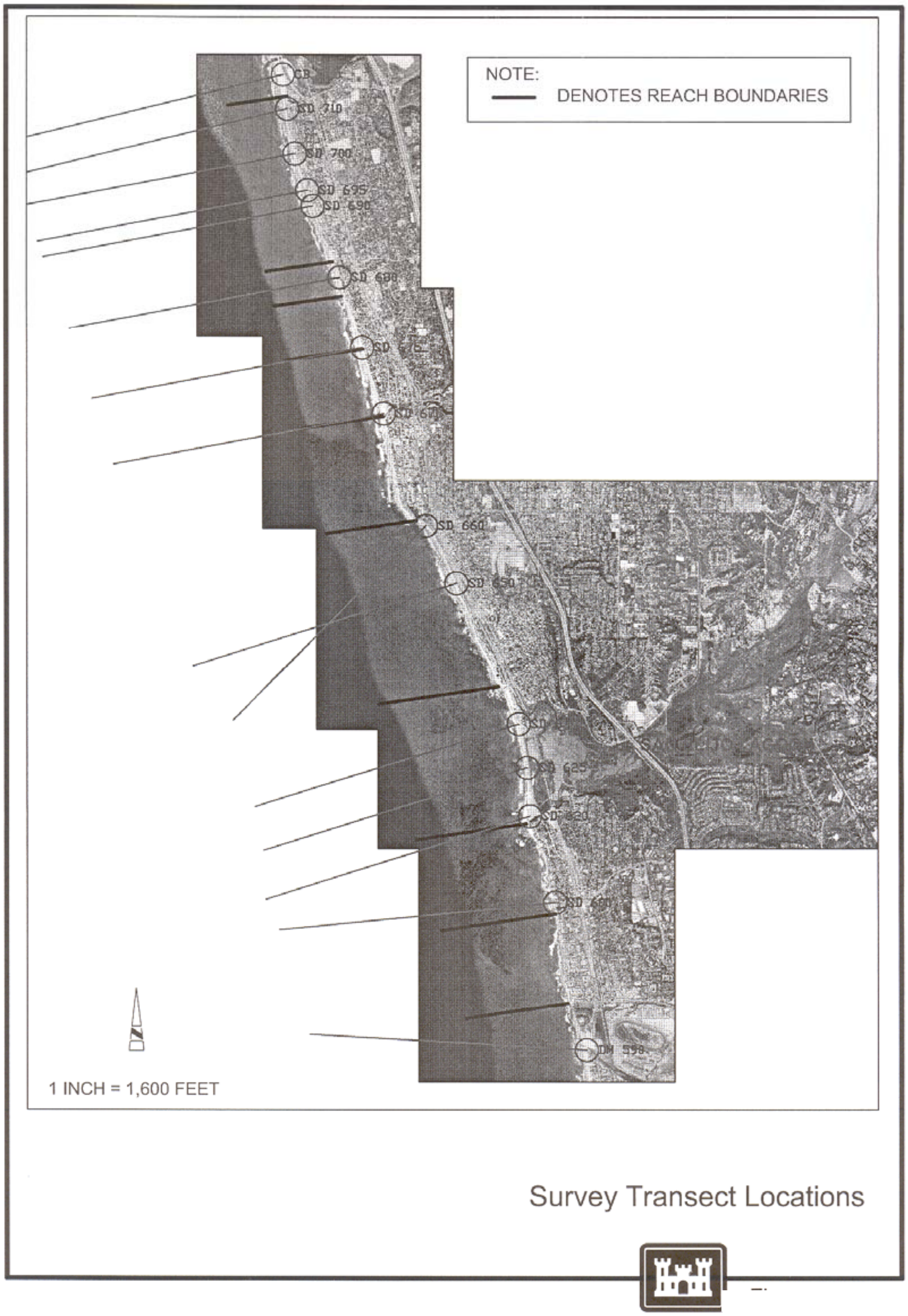
Since the late 1970s and early 1980s, Southern California has experienced a series of unusual weather patterns when compared to the rest of this century (see Coastal Appendix). Fluvial delivery has also been significantly reduced due to river damming and inland sand mining activities. The cumulative effects of these impacts have produced erosion of the once-wide, sandy beaches. As a result of the severe winter storms in the 1982-1983 El Nino year and the extreme storm of 1988, most of the thin sand lens on the Encinitas beaches was lost even prior to the 1997-1998 El Nino season. Within Solana Beach, the chronically denuded beach condition was also worsened after the 1997-1998 season. It is apparent that beach sands were stripped away and lost from the littoral system during that season.

2.6.3.3 Present Day – Nourishment and Depletion

More recently, the depleted beaches within the Encinitas and Solana Beach shoreline were selectively widened through mechanical sand replenishment activities. Sands dredged from Batiquitos Lagoon were placed at Batiquitos Beach in 1998 and 2000 to establish a feeder beach that could provide sand to the downcoast shoreline through littoral drift. The SANDAG's Regional Beach Sand Project completed in 2001 also placed approximately 457,500 cubic meters (600,000 cubic yards) at Batiquitos Beach, Leucadia, Moonlight Beach, Cardiff and Fletcher Cove (NCI, 2001). Beach profile surveys taken in summer 2002 indicated that the placed sediment had dispersed alongshore both upcoast and downcoast of the beach-fill sites. **Figure 2-15** shows the location of these survey transects. A comprehensive presentation of all available beach profiles taken at these transects in the past 70 years can be found in the Coastal Engineering Appendix.

Although several winter storms in the 2002-2003 season have caused the beach to retreat to nearly the same position as before the SANDAG project, it is not yet known whether the sand was deposited in offshore bars, to be returned to the beach in summer months, or was carried entirely out of the littoral system.

FIGURE 2-15. BEACH TRANSECT LOCATIONS

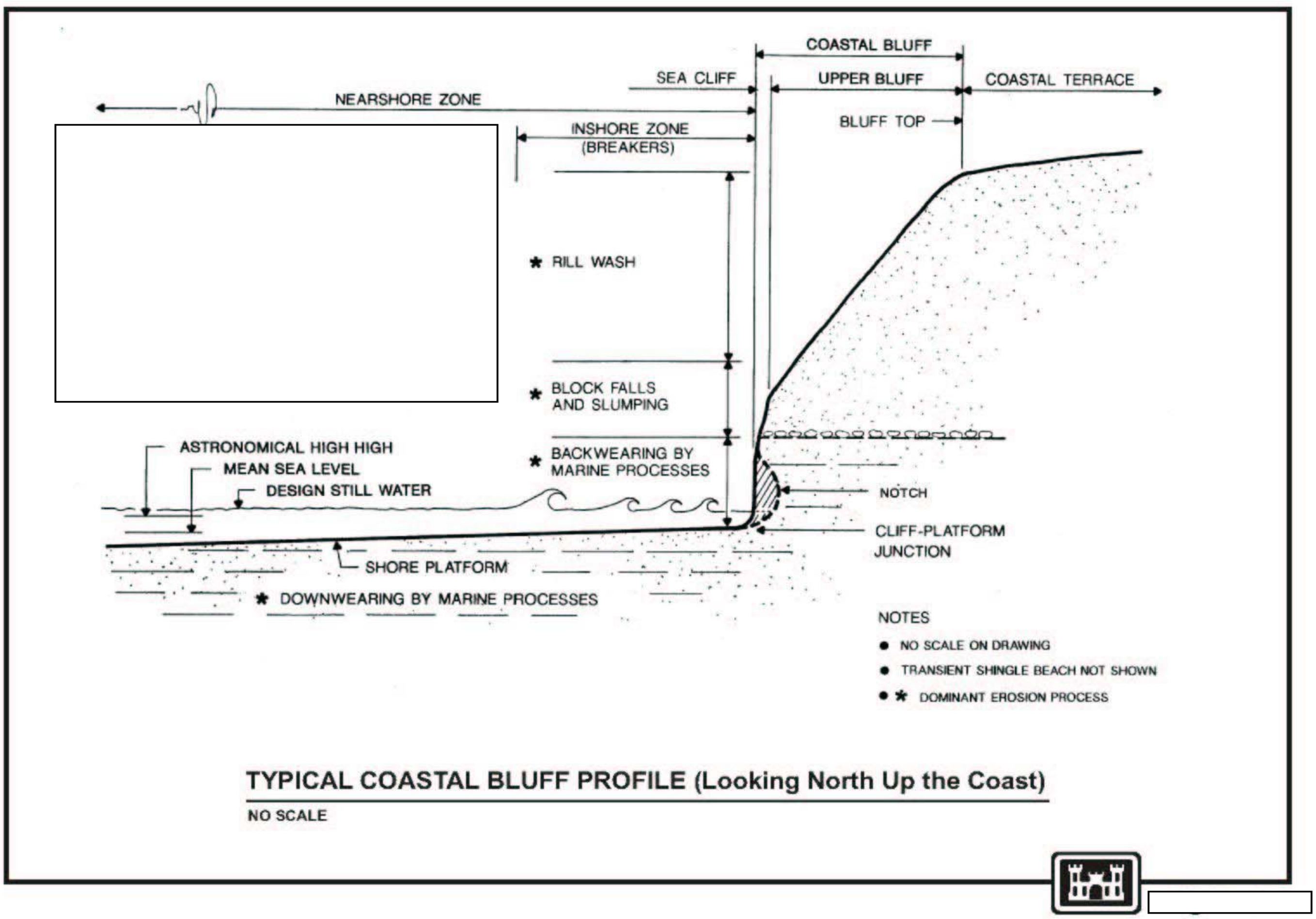


2.7 Coastal Bluff Erosion Processes

2.7.1 Long-Term Average Retreat vs. Large Episodic Failures

Shoreline retreat is defined as the gradual landward movement of the sea/land boundary as defined by the location of some tidal datum such as MSL. In the study area, this retreat is generally caused by shoreline erosion caused by wave attack of the beach and bluffs. Retreat of the coast may occur gradually, at a relatively uniform rate, or episodically, in large increments, followed by long periods of little or no retreat. Gradual retreat is well represented by annualized retreat rates; however, annualized rates do not adequately describe the nearly instantaneous retreat of several feet or tens of feet that may occur episodically. Episodic retreat affects both the seacliff face and bluff top. The seacliff is affected by large wave events eroding seacaves at the bluff toe and triggering block topping and block fall, collapsing these "notch caves". The subaerial processes (rain, rilling, surficial overslope flow) acting on the bluff surface and crest generally produce a slower, more uniform erosion rate, but may also contribute to episodic failure over the longer term. In addition, deep-seated landslides can cut back into the coastal terrace upwards of 60 to 80 feet in a few hours or days. **Figure 2-16** shows a typical bluff profile in the study area.

FIGURE 2-16. TYPICAL BLUFF PROFILE



2.7.2 Role of the Beach in Protecting the Toe

Before the 1970s, beaches in the study area generally were wide enough to provide protection to the coastal bluffs, and the shoreline was more stable. However, since the beach was lost, the annualized rate of marine erosion of the seacliff has at least doubled in Encinitas, and has increased an order of magnitude in most of Solana Beach. Wherever the bluff is protected by a seawall or revetment, marine erosion is arrested as long as the shore protection is properly designed, built, and maintained.

2.7.3 Toe Erosion vs. Bluff Top Retreat

When averaged over thousands of years, bluff toe and bluff-top erosion rates will be equal. However, viewed over shorter time scales (decades) during changing climatic conditions, the two rates tend to vary within a given range, depending on the mode or stage of erosion. The mechanisms of coastal bluff erosion can be roughly divided into three different modes. In the first, there is little or no toe erosion and the retreat rate is generally slow and is determined by subaerial processes. Erosion at the toe occurs at about the same rate as at the top, and the bluffs have reached an equilibrium angle of repose. In the second mode, toe erosion has accelerated (due to wave attack) beyond the bluff top erosion rate, causing gradual steepening of the bluff, starting at the bottom and working its way up. In the third mode, this steepening has reached the top, and the rates of erosion are roughly equal at the top and bottom and are much higher than the other modes because they are driven by the toe erosion rate. **Figure 2-17** shows a schematic of these three modes of bluff erosion and the transitional stages between them, and **Figure 2- 18** shows a typical bluff failure sequence driven by toe erosion. The following subsections describe these three modes briefly, and the Geotechnical Appendix contains further analysis and description.

2.7.3.1 Subaerial Driven Equilibrium Mode

When the bluff toe is protected by a sandy beach, or there is simply insufficient wave energy to cause toe erosion from wave attack, the bluff top is still subject to subaerial processes that cause very slow retreat at a rate of approximately 0.05 to 0.10 feet per year. As the upper bluff erodes slowly, its slope becomes flatter until it reaches a stable angle of repose (see **Figure 2-16**).

> Along coasts of the type at Encinitas and Solana Beach, the slope decline relationship shown on this figure would suggest that upper bluff slopes of less than 25 degrees should develop if marine erosion were arrested for a long enough period. Under pre-development conditions, before the beach was lost, annualized rates of seacliff and bluff-top retreat were approximately equal, having been in equilibrium for thousands of years. This natural rate was approximately 0.1 foot per year (for the last 6,000 years). Although the historic record shows several long term oscillations between periods of high and low storm wave energy, between about 1900 and 1975, a period of low energy allowed the coastal bluffs to reach near equilibrium when the upper slope gradually retreated to a stable angle of repose under the influence of subaerial processes.

FIGURE 2-17. PROCESSES OF COASTAL BLUFF EROSION

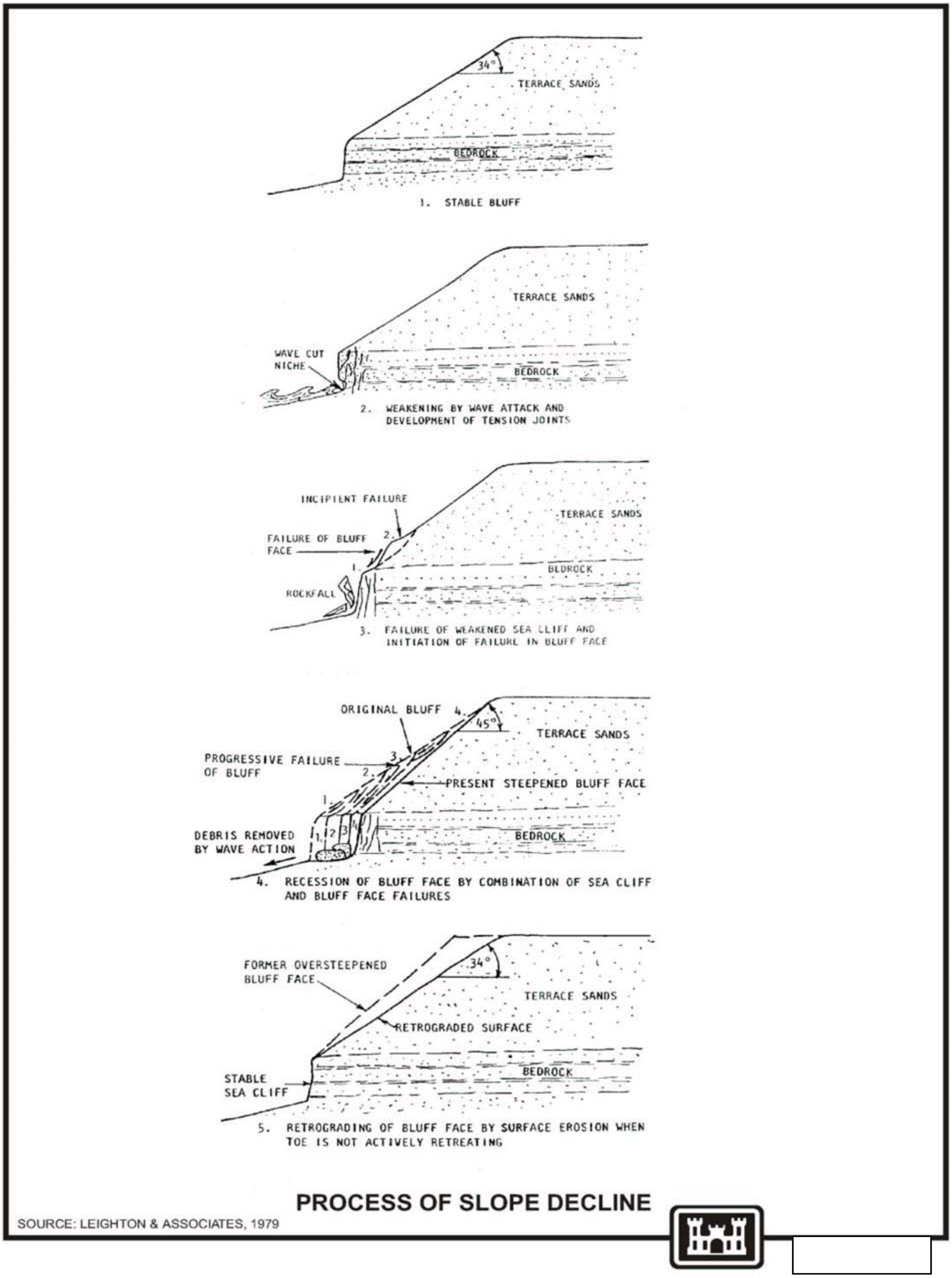


FIGURE 2-18. TYPICAL BLUFF FAILURE SEQUENCE

1. Area 1 November 11, 1998. Notch depths throughout north Solana Beach were surveyed in July 1998 (Group Delta, 1998) after the 1997-98 El Niño storms. Pre-El Niño photographs suggest little notch development. In July 1998, the notch depth in this area was 9 feet. This overhang collapsed in early November 1998 after minor additional notch growth.

2. Area 1 October 6, 1999. Eleven months later, additional notch growth in this area caused this major collapse on October 1, 1999.

3. Area 3 November 4, 1998. By July 1998, a 6- to 10-foot-deep notch had formed in this area.

4. Area 3 April 10, 2000. A notch infill had been permitted in early 2000, and during construction, an additional 1 to 3 feet of notch growth had been recorded between July 1998 and April 2000.

TEMPORAL EROSION - PHOTO SEQUENCE

2.7.3.2 Bluff Toe Driven Transition Mode

Since about 1980, accelerated bluff toe erosion has caused large block failures and significant steepening of the bluff face. In most of the study area, the retreat of the bluff toe and resulting block fall events have caused oversteepening of the bluff face. In some areas, the bluff top still maintains some remnant of its former equilibrium slope, but the oversteepened bluff face is gradually eroding its way up to the top, and will eventually cause blufftop retreat/failure if unchecked. This is because wave-induced erosion at the toe is faster than sub-aerial erosion at the top. In this mode, annualized bluff toe erosion rates will be greater than those at the bluff top, but not for long since this is usually a transition between the first and third modes.

2.7.3.3 Bluff Toe Driven Equilibrium Mode

In this mode, severe toe erosion has caused oversteepening of the bluff face all the way to the top of the bluff, reaching a new, steeper, profile where both bluff toe and bluff top annualized erosion rates become equal, and are driven by the toe erosion rates. Although there may still be some lag time between lower and upper bluff failures, in general, the steeper and shorter the bluff face, the more quickly it will erode or collapse in response to wave-induced erosion/notching at the toe. **Figure 2-18,** above shows an example of this in Solana Beach.

2.7.4 Calculating Erosion Rates

In general, average annualized bluff-top erosion rates throughout the study area are somewhat less than the corresponding bluff toe erosion rates due to those portions of the bluff that are still in the second mode, where toe erosion has not “caught up” to top erosion. When computing weighted averages, this tends to reduce the bluff top erosion rate when compared to the toe erosion rate. Thus, in predicting annualized erosion rates for the next 50 years, **Table 2-6** reflects a slightly higher toe erosion rate to account for the gently-sloping upper bluff in some areas, whose retreat will at least temporarily lag erosion at the toe.

Table 2-6 also reflects the anthropic or human impacts associated with a total loss of transient beach sand, and also assumes that no beach nourishment (excepting lagoon and harbor bypass operations) will occur within the 50-year study period. The predicted future erosion rates also assume that the erosion that has occurred in the last 25± years, associated with more intense wave energy, will continue for the next 50 years.

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Table 2-6. Summary of Seacliff and Blufftop Erosion Rates Existing Conditions for the Solana Beach-Encinitas Shoreline 2002		
Reach	**Seacliff (ft/yr)**	**Blufftop (ft/yr)**
1	0.3	0.2
2	0.4 - 0.5	0.3 - 0.5
3	1.2	1.2
4	1.1	1.0
5	0.6	0.6
6	0.2 - 1.0	0.15 - 1.0
7	Beach, no cliff or bluff	---
8	0.4 - 1.2	0.4 - 1.2
9	0.4 - 1.2	0.4 - 1.2

Notes:
1. Erosion rates are for coastal bluffs not affected by deep-seated landsliding. Site specific geotechnical investigations might reveal susceptible areas.
2. Where a partially cemented cap of terrace deposits or dune sand exists, the subaerial erosion rate will be less.
3. Where anthropic activities such as foot traffic and high landscape irrigation occur, subaerial erosion may be higher.

2.8 Environmental Resources

The Environmental Impact Statement (EIS) included with this report provides a detailed description of environmental resources and threatened and endangered species. The following summarizes the information contained in the EIS. If the resources are the same for all reaches, the description applies to all reaches; if not, the resource is described by reach.

2.8.1 Water Resources

Ocean water temperatures vary seasonally, with minimum temperatures of approximately 14 degrees Celsius (°C) in winter and maximum temperatures of 22°C in summer. Depth-related differences in water temperatures occur during summer, with surface water temperatures up to 10°C warmer than those in deeper waters.

2.8.1.1 Temperature

Offshore waters typically are stratified (thermocline/pycnocline develops) during the summer and fall, unstratified during the winter, and transitional (e.g., stratification weakening or increasing) in late fall and spring. Thermoclines represent barriers to mixing between surface and bottom waters. Offshore temperatures in the study area range from 11.0 to 23.5 ºC (52 to 74 degrees Fahrenheit - ºF) near the surface, and from 9.5 to 16.0ºC (49 to 61ºF) near the bottom (KEA 1990; MEC 1997, 2000a). Nearshore water temperatures are slightly warmer in the range of 14 to 24ºC (57 to 75 ºF), and tend to be more uniform throughout the water column due to turbulent mixing and shallower depths (Dailey et al. 1993).

2.8.1.2 Salinity

Historical salinity levels are fairly uniform, ranging from 33 to 34 parts per thousand (‰) within the study area (KEA 1990; MEC 1997, 2000a). Salinity levels are relatively homogenous throughout the water column, with differences typically less than 1‰ from surface to bottom waters. The exception is during winter storms when freshwater runoff reduces surface water salinity, especially at nearshore locations. Salinity levels in both surface and bottom waters may be slightly higher from April to August due to upwelling of denser bottom waters.

2.8.1.3 Dissolved Oxygen

Historical dissolved oxygen values range from 5.0 to 11.6 milligrams per liter (mg/L) throughout the study area (MEC 1997, 2000a). Natural deviations of dissolved oxygen result from a combination of factors, including intrusions of water masses, primary production (phytoplankton blooms), and upwelling/downwelling events. Concentrations of dissolved oxygen in surface and nearshore waters generally are high due to mixing at the water/atmosphere interface and continuous wave action.

2.8.1.4 pH

Historical pH values range from 7.7 to 8.4 within the study area (MEC 1997, 2000a). Slightly higher pH values occur during May through September when water temperatures are warmer, and in surface waters as related to equilibrium with carbon dioxide in the atmosphere.

2.8.1.5 Bacteria

Several storm drains have outlets onto beaches within the study area. The Cities of Encinitas and Solana Beach have been required to monitor bacterial levels at storm drain outlets and in the adjacent surfzone since 2001. Elevated bacteria concentrations have been measured at the outlets of the storm drains at varying frequencies depending upon the storm drain. However, all bacteria concentrations measured in the surfzone downcurrent of the storm drains have been within AB-411 standards for surfzone water contact recreation.

2.8.1.6 Tides

Tides along the southern California coastline are of the mixed semi-diurnal type. Typically, a lunar day (about 24 hours) consists of two high and two low tides, each of different magnitudes. Daily tides generally range between 1 to 3 meters (3 to 10 feet). A lower low tide normally follows the higher high tide by approximately seven to eight hours while the time to return to the next higher high tide (through higher low and lower high water levels) is usually approximately 17 hours. Annual tidal peaks typically occur during the summer and winter seasons. The increased tidal elevations during the winter season can exacerbate the coastal impacts of winter storms.

2.8.1.7 Waves

Wind waves and swell within the study area are produced by six basic meteorological weather patterns. These include extratropical storm swells in the northern hemisphere (north or northwest swell), wind swells generated by northwest winds in the outer coastal waters (wind swell), westerly (west sea) and southeasterly (southeast sea) local seas, tropical storm swells and hurricanes off the Mexican coast, and southerly swells originating in the southern hemisphere (southerly swell).

2.8.2 Biological Resources

The sections below discuss threatened and endangered species and species of concern only. A full detailed accounting of all study area flora and fauna can be found in the EIS.

The study area lies within an ecologically important region of San Diego County with its unique and diverse natural resources. San Elijo Lagoon occurs within the study area, and Batiquitos and San Dieguito

Lagoons occur adjacent to the north and south boundaries, respectively. The nearshore environment has a variety of substrates ranging from sand to high-relief reef, and kelp beds occur on reefs farther offshore. These reefs harbor a variety of macroalgae, invertebrate, and fish populations.

Sand occurs offshore a substantial portion of the study area. The major portion of the shoreline consists of narrow sand and cobble beaches backed by coastal bluffs. Sandy beaches, both in the intertidal and shallow subtidal elevations, are unstable habitats with seasonal cycles of sand erosion and accretion. Typically, there is variability in the invertebrate and avian populations that inhabit the sands. The 590-acre San Elijo Lagoon is comprised of a high diversity of habitats, which include saltmarsh, mudflats, aquatic channels, salt pannes, freshwater and brackish water marsh, and adjacent upland habitats which include coastal strand, coastal sage scrub, mixed chaparral, riparian, etc.

Along the coastal bluffs, the shoreline beach habitat consists of a mixture of fig marigold (*Carpobrotus* sp.), a non-native species; native species are sparse and occur in localized areas. Native vegetation found in this area include Diegan coastal sage scrub species, coastal prickly pear (*Opuntia* littoralis), salt marsh fleabane (*Pluchea* ordorata), and western marsh rosemary (*Limonium* californicum). The western fence lizard (*Sceloporus occidentalis*) has been observed in the study area. Other species with low to moderate potential to occur include California side-blotched lizard (*Uta stansuriana elegans*), coastal western whiptail lizard (*Cnemidophorus tigris multiscutatus*), orange-throated whiptail (*Cnemidophorus hyperythrus beldingi*), and silvery legless lizard (*Anniella pulchra pulchra*). Terrestrial birds associated with the shoreline and bluff habitat consists of urban adapted species such American crow (*Corvus brachyrhynchos*), house finch (*Carpodacus mexicanus*), and rock dove (*Columba livia*). In addition, black phoebe (*Sayornis nigricans*), bushtit (*Psaltriparus minimus*), and song sparrow (*Melospiza melodia*) have been commonly observed.

The upper intertidal or splash zone is characterized by simple green algae (*Chaetomorpha* spp., *Enteromorpha* spp., *Ulva* spp.), barnacles (*Cthamalus* spp.), limpets (*Collisella* spp., *Lottia* spp.), and periwinkles (*Littorina* spp.). Shorebirds found in the study area include black turnstone (*Arenaria melanocephala*), marbled godwit (*Limosa fedoa*), sanderling (*Calidris alba*), whimbrel (*Numenius phaeopus*), and willet (*Caloptrophorus semipalmatus*). Marsh birds, including great blue heron, great egret, and black-crowned night heron (*Nycticorax nycticorax*), have been observed foraging on exposed reefs. Other commonly observed and/or expected shorebirds in the project area include killdeer (*Charadrius vociferus*), black-bellied plover (*Pluvialis squatarola),* wandering tattler (*Heteroscelus incanus*), and spotted sandpiper (*Actitis macularia*).

Filamentous red and corraline algae, California mussel (*Mytilus californianus*), gooseneck barnacle (*Pollicipes polymerus*), aggregating sea anemones, chitons, hermit crabs, and a variety of marine snails (e.g., *Acanthina* spp., *Lithopoma undulosa*, *Kelletia kelletia*., *Ocenebra* spp., *Tegula* spp.) are commonly observed in the middle intertidal zone of rocky shores. Surfgrass (*Phyllospadix* spp.) provides important habitat for a variety of algae, invertebrates, and fish.

Surfgrass generally grows on hard-substrate from approximately 0 to -6 meters (-20 feet) MLLW. It may form conspicuous beds in the low intertidal to shallow subtidal zones of rocky beaches. Up to 34 species of algae and 27 species of invertebrates may be associated with surfgrass on San Diego beaches (Stewart and Myers 1980). One notable invertebrate is the California spiny lobster (*Panuliris interruptus*), which uses surfgrass as a nursery habitat. Fish commonly found in surfgrass habitats off San Diego include barred sand bass (*Paralabrax nebulifer*), black perch (*Embiotoca jacksoni*), blacksmith (*Chromis punctipinnis*), garibaldi (*Hypsypops rubicundus*), opaleye (*Girella nigricans*), señorita (*Oxyjulis californica*), and topsmelt (*Atherinops affinis*) (DeMartini 1981; MEC 1995).

The low to minus intertidal zone of persistent reefs are characterized by a greater diversity of plants and animals, including coralline algae, a variety of other red algae, brown algae, surfgrass, aggregating and green sea anemones (*Anthopleura elegantissima*), purple sea urchin (*Strongylocentrotus purpuratus*), California sea hare (*Aplysia californica*), crabs, marine snails, brittlestars (e.g., *Ophithrix* spp.), and starfish (*Asterina miniata*, *Pisaster* spp.). Nearshore kelp and macroalgae include feather boa kelp (*Egregia* *menziesii*), which is a conspicuous and common species that ranges from low intertidal to shallow subtidal depths. A variety of red (*Corallina* spp.*, Erythroglossum californicum*, *Gigartina* spp., *Gracillaria* spp., *Jania* spp., *Litothrix* spp. *Rhodoymenia* spp.) and brown macroalgae (*Cystoseira osmundacea*, dictyotales, *Zonaria farlowi*) may co-occur with feather boa kelp on nearshore reefs (MEC 1995; U.S. Navy 1995).

Offshore kelp beds Southern California kelp forests are dominated by giant kelp (*Macrocystis pyrifera*), which grows at depths between -6 and -36 meters (-20 and -120 feet) MLLW. Giant kelp, and its associated hard bottom habitat, supports a diverse community of algae, invertebrates, and fish. Lobsters, marine snails, sea stars, and sea urchins commonly occur within giant kelp beds. California sheephead (*Semicossyphus pulcher*), garibaldi, kelpfish (*Heterostichus rostratus*), kelp bass (*Paralabrax clathratus*), opaleye, surfperch, rockfish (*Sebastes* spp.) are common resident species. Transient fish such as jack mackerel (*Trachurus symmetricus*), Pacific bonito (*Sarda chiliensis*), Pacific barracuda (*Sphyraena argentea*), and silversides also commonly occur. In addition, kelp beds provide food for marine birds and mammals. Gulls commonly scavenge on the surface canopy, and cormorants, pelicans, and terns feed on schooling fish near the edge of the canopy.

Seals, sea lions, and whales forage within kelp beds. California sea lions (*Zalophus californicanus*) and harbor seals (*Phoca vitulina*) may, on occassion, be seen on beaches in north San Diego County (U.S. Navy 1997a, b). Common dolphins (*Delphinus delphis*) and bottlenose dolphins (*Tursiops truncatus*) occur in the surfzone and in offshore waters. A coastal population of bottlenose dolphins occurs within 1 kilometer (0.6 mile) of shore off southern California (Bonnell and Dailey 1993). Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) and Risso's dolphins (*Grampus griseus*) also are known to occur seasonally.

California gray whales (*Eschrichtius robustus*) transit the study area. The southbound migration begins in December and lasts through February, and the northbound migration is from February through May. Gray whales migrate up to 200 kilometers (125 miles) offshore along three pathways while passing through the Southern California Bight.

2.8.2.1 Coastal Wildlife Species

Seven species that are federally or state-listed as endangered or threatened either occur or have the potential to occur within the project area based on literature review and an assessment of the habitat types within the study area. These species and the rationale for the determination of their potential occurrence within the study area are discussed below.

Belding's savannah sparrow (*Passerculus sandwichensis beldingi*)

Belding's savannah sparrow is state-listed as endangered species. Belding's savannah sparrows are found in coastal salt marshes from Santa Barbara south to San Diego County. This species nests exclusively in pickleweed (Salicornia sp.) and is often found in and around the margins of tidal flats. CNDDB occurrences for locations of nesting savannah sparrows include Batiquitos and San Elijo Lagoons. Therefore, Belding's savannah sparrows have a high potential to occur within the study area, but would be unlikely to occur along the bluffs or shoreline because of a lack of suitable habitat. They may occasionally forage in these areas especially during the non-breeding season.

California brown pelican (Pelecanus occidentalis californicus)

The California brown pelican is a federally- and state-listed endangered species. This species was listed following several years of pollutant-related reproductive failures. Individuals are observed along the entire California coast following the breeding season when individuals leave their nesting colonies in the Channel Islands and in Mexico. In southern California, California brown pelicans are common along the coast from June to October, especially within 32 kilometres (20 miles) of the shore. Brown pelicans feed almost entirely on fish, caught by diving from the air. They usually rest on the water or inaccessible rocks, but also use mudflats, sandy beaches, wharfs, and jetties. California brown pelicans were observed within Reach 2 during a 2002 survey, and can be expected to forage in nearshore waters throughout the study area.

California least tern (Sterna antillarum browni) nesting colony

The California least tern is federally- and state-listed as endangered. This species is a breeding migrant in San Diego County. The least tern nesting season extends from April 1 to September 15. California least terns nest in loose colonies in areas relatively free of human disturbance; they will abandon nesting areas if disturbed. Nests occur on the ground on sparsely vegetated sandy or gravelly substrate. CNDDB occurrences for locations of nesting tern colonies include Batiquitos and San Elijo Lagoons. Least terns are visual predators on small fish, and they usually forage within a two-mile radius of their nesting site, although they may forage as far as five miles away. This species can be expected to forage in nearshore waters throughout the study area.

Coastal California Gnatcatcher (Polioptila californica californica)

The coastal California gnatcatcher is federally-listed as threatened and is considered a California Species of Special Concern. This non-migratory, insectivorous bird nests and forages in moderately dense stands of coastal sage scrub occurring on arid hillsides and mesas, and in washes. Coastal sage scrub communities dominated by California sagebrush, California buckwheat, white sage, and black sage are preferred by this species. The closest CNDDB occurrences are located in the upland habitat associated with Batiquitos and San Elijo Lagoons. Additionally, California gnatcatchers have been observed within 1.6 to 3 kilometers (1 to 2 miles) of the study area, primarily in the southern reaches (Ogden and CBI 2001).

In general, the coastal bluffs within the study area are dominated by non-native plant species, primarily fig marigold. However, a few Diegan coastal sage scrub species interspersed with a large amount of exotic vegetation occur in a small area bordering the south end of a parking lot west of Highway 101 and just south of Batiquitos Lagoon (Reach 1) and in a small planted area in Reach 4. However, these areas contain such sparse vegetation that they do not constitute identifiable vegetation communities and, therefore, do not represent suitable breeding or foraging habitat for coastal California gnatcatcher. Thus, the potential for coastal California gnatcatcher to occur in the shoreline portion of the study area is low.

Western snowy plover (Charadrius alexandrinus nivosus) nesting colony

The western snowy plover is federally-listed as threatened and is considered a California Species of Special Concern. This species inhabits sandy beaches, salt pond levees and shores of large alkali lakes. Snowy plovers require sandy or friable soils for nesting. CNDDB occurrences for locations of nesting plover colonies include Batiquitos and San Elijo Lagoons. In 2002, western snowy plovers also bred at San Deiguito Lagoon (R. Patton, personal communication 2002). Additionally, this species can be expected to forage along the shoreline. Western snowy plover were observed on the beach south of Batiquitos Lagoon, on Cardiff State Beach south of San Elijo Lagoon (usually about midway between the restaurants and the south parking lot), and in the lagoon inlet of San Dieguito Lagoon in 2002 (R. Patton, personal communication 2002).

Pacific pocket mouse (Chaetopidus longimembris pacificus)

The Pacific pocket mouse is a federally-listed endangered species and is considered a California Species of Special Concern. This species inhabits narrow coastal plains from the Mexican border north to El Segundo, Los Angeles County, and prefers fine alluvial sands and sandy substrates near the ocean. All known locations have been within 4 kilometers (2.5 miles) of the coast and below 182 meters (600 feet) in elevation (USDA 1999). he closest known CNDDB occurrence is located on the east side of Lux Canyon, at the head of the San Elijo Lagoon, approximately 3 to 5 kilometers (2 to 3 miles) from the coast. Additionally, Batiquitos and San Elijo Lagoons are identified in the recovery plan as areas that should be surveyed to locate potential populations (USFWS 1998). Although the coastal bluffs within the study area are heavily disturbed and are isolated due to residential developments, this species has a moderate potential to occur within the study area.

2.8.2.2 Coastal Plant Species

The literature review resulted in a list of several sensitive plant species that have historically occurred in north San Diego County (Del Mar, Encinitas, Rancho Santa Fe or San Luis Rey quadrangles). The potential for the federal- and state-listed or proposed threatened or endangered species to occur within the study area are summarized in the following paragraphs **.**

Coastal dunes milk-vetch (Astragalus tener var. titi)

Coastal dunes milk-vetch is a federally-listed and state-listed endangered species. This annual herb flowers from March to May. It occurs in sandy coastal bluff scrub, coastal dunes and mesic coastal prairies; however, coastal dunes milk-vetch prefers coastal dunes. One population for this species is known to be extant on a coastal bluff in Monterey County; however it is presumed extirpated in southern California and close to extinction (Reiser 1994). Although coastal dunes are not present withint the study area, a portion of the area is mapped as loamy coarse sand. This species has a low potential for occurrence because the habitat needed to support this species is of poor quality and no recent or historical record of the species exists within the study area or its immediate vicinity.

Del Mar manzanita (*Arctostaphylos glandulosa ssp. crassifolia*)

Del Mar manzanita is a federally-listed endangered species. This evergreen shrub flowers from December through April. It occurs in maritime chaparral on sandy soils. Del Mar manzanita typically occurs in eroding sandstone with low-growing chaparral vegetation on terrace escarpment and loamy alluvial land soils of the Huerhuero complex (Reiser 1994). Although maritime chaparral does not occur within the study area, a portion of the area is mapped as terrace escarpment. This species has a low potential for occurrence because the habitat needed to support this species is of poor quality, and no species of manzanita were observed.

Encinitas baccharis (Baccharis vanessae)

Encinitas baccharis is a federally-listed threatened and state-listed endangered and rare species. This deciduous shrub flowers from August to November. Encinitas baccharis occurs in chaparral and cismontane woodland on sandstone. It has been documented in loamy sand and sandy loam soils, and is associated with chamise (Reiser 1994). Although no chaparral or cismontane woodland exists on-site, portions of the study area have been mapped as loamy coarse sand and fine sandy loam. This species has a low probability for occurrence because the habitat needed to support this species is of poor quality.

Orcutt's spineflower (Chorizanthe orcuttiana)

Orcutt's spineflower is a federally-listed and state-listed endangered species. This annual herb flowers from March to May. Orcutt's spineflower occurs in sandy openings in maritime chaparral and closed-cone coniferous forests with a distinctive loose sandy substrate. It has been known to occur in Corralitos loamy sand, loamy alluvial land in the Huerhuero complex, Carlsbad gravelly loamy sand, and Gaviota fine sandy loam. Approximately 20 individuals of this species were observed at Oak Crest Park in Encinitas in 1991 in a chaparral clearing in loose sand downslope from eroded sandstone bluffs (Reiser 1994). Loamy coarse sand, fine sandy loam, and loamy or gravelly soils are mapped for the site; however, this species has a low probability for occurrence because the habitat needed to support the species is of poor quality.

San Diego ambrosia (Ambrosia pumila)

San Diego ambrosia is a federally-listed endangered species. This perennial herb flowers from May through September. It occurs on chaparral, coastal scrub, valley and foothill grassland, and vernal pools often in alkaline soils and disturbed areas. Creek beds, seasonally dry drainages, and floodplains are the preferred historical habitat of this species, which usually occurs on the periphery of willow woodland (Reiser 1994). Although the preferred habitat of this species does not exist within the study area, San Diego ambrosia has been known to occur in disturbed habitats. A small area with a few remnant Diegan coastal sage scrub species does exist within the study area. This species has a low potential to occur because no historical record of the species exists within the study area and marginal suitable habitat exists.

Short-leaved dudleya (Dudleya brevifolia)

Short-leaved dudleya is a state-listed endangered species. This perennial herb flowers in April. Short-leaved dudleya occurs in openings in maritime chaparral and coastal scrub on Torrey sandstone and prefers soils mapped as Carlsbad gravelly loamy sand (Reiser 1994). Although this specific soil type is not mapped within the study area, loamy coarse sand is mapped in the project area. This species has a low probability for occurrence because the habitat needed to support the species is of poor quality.

2.8.3 Cultural Resources

Coastal Shoreline

The records and literature search has identified numerous prehistoric and historic archaeological sites and properties within the study area. The study area for this project begins at T 13 S, R 4 W, Section 4 of the USGS Topographic Quad Encinitas, CA and extends down the coast into T 14 S, R 4 W, Section 2 of the USGS Topographic Quad Del Mar, CA. The project area has been impacted by the development of residential and commercial properties in cities such as Encinitas, Cardiff-by-the-Sea, Solana Beach and parts of Del Mar. A large majority of the study area has been surveyed for cultural resources from the early 1970s to mid-1990s. In 1992-94, Brian Smith surveyed and investigated the coastline from Batiquitos Lagoon down to Del Mar for the proposed San Elijo Water Reclamation System Project. His findings are documented in *Results of an Archaeological Evaluation of Cultural Resources Within the Proposed Corridor for the San Elijo Water Reclamation System* (Smith 1995). His report did not focus on sites located within the study area for this project. In addition, the search identified site record forms for eight historic properties located within the study area. The site forms describe these sites in poor condition. A Corps archaeologist will conduct a pedestrian survey of the area as soon as a project alternative is selected in a final attempt to identify and evaluate historic properties that would be impacted by this proposed project.

Offshore Borrow Sites

Ten thousand years ago the global sea level averaged about 100 feet below the present shoreline. Given the concentration of sites along the modern shoreline, it is reasonable to expect submerged sites would also exist along paleo-shorelines dating from the 10,000 – 3,000 before present time period. Divers have reported numerous prehistoric artifacts in the nearshore zone of the San Diego region. Artifacts may be carried and found offshore by onshore erosion, and/or they may have fallen off prehistoric sea-going watercraft, and/or they may be associated with prehistoric sites that have been submerged by rising sea levels. It has also been speculated that kelp rafting may be responsible for transporting artifacts along the shelf.

It is important to keep in mind that the distribution of reported sites may be predominately dependent upon the location of sport diving and for this reason shallow sites are more likely to be reported. In addition, artifacts at depths below 20 meters (66 feet) may be rare because of the difficulty and limited dive times at these depths. Another significant factor is sediment cover. In the La Jolla and Point Loma areas there is limited sediment cover to obscure the presence of artifacts. For example, commercial urchin divers report numerous stone mortar localities in these areas.

In 2000, the San Diego Regional Beach Sand (SANDAG) Project's environmental document reported 37 offshore prehistoric artifact locations/sites. The largest by far is an archaeological site located off the coast of La Jolla at a depth of 27 meters (90 feet) consisting of more than 2,000 stone mortars along with stone pestles, metate fragments, manos, flaked lithics, and grooved stones that may have been used as net weights. In addition to prehistoric sites, several historic shipwrecks have been documented. The model used in the SANDAG study predicted that older sites would be most likely to occur within marsh habitats and the most recent sites within lagoon habitat. These assessments were made based on the likelihood of occurrence, detection, preservation, and recoverability of both prehistoric and historic cultural resources. Their approach was based on the Mineral Management Service (MMS) method utilized to assess submerged (and often buried) areas for cultural resource sensitivity.

A large majority of the APE has been surveyed for cultural resources from the early 1970s to mid-1990s. In 1992-94, Brian Smith surveyed and investigated the coastline from Batiquitos Lagoon down to Del Mar for the proposed San Elijo Water Reclamation System Project. His findings are documented in *Results of an Archaeological Evaluation of Cultural Resources Within the Proposed Corridor for the San Elijo Water Reclamation System* (Smith 1995). His report did not focus on sites located within the APE for this project. In addition, the search identified site record forms for eight historic properties located within the APE. The site forms describe these sites in poor condition

2.8.4 Air Quality

Existing levels of air quality at and near the study area can best be inferred from ambient air quality measurements conducted by the SDAPCD at its Del Mar monitoring station located to the south. Unfortunately, this station only monitors ozone. The nearest coastal station that monitors carbon monoxide and nitrogen dioxide is located to the north in Oceanside. However, even this station does not monitor particulates and these data are best inferred from the Escondido station, which is the most proximate station that monitors particulates.

Ambient levels of monitored air pollutants have remained fairly constant over the past 5 years with no clear-cut trends. The study area is within a larger area that is designated as non-attainment under the state air quality standards for certain pollutants (i.e., ozone and particulate matter) and the federal ozone standard. The data show that the area is sensitive to pollutants that are precursors to ozone (i.e., nitrogen oxides and reactive organic hydrocarbons) because this standard is exceeded, though only on an infrequent basis. The EIS includes a table of these pollutants monitored from 1997 through 2001.

2.8.5 Noise

Noise measurements were made in the project area at various coastal locations to provide information for the EIR/EIS for the San Diego Regional Beach Sand Project (SANDAG 2000a). Those noise measurements were made between July 26 and September 27, 1999, using a Larson-Davis Laboratories Model 712 Type 2 sound level meter. The results of those measurements are summarized below by Reach:

2.8.5.1 Reach 1 – Batiquitos Lagoon to Beacon's Beach

A measurement was made at night for the EIR/EIS for the San Diego Regional Beach Sand Project on the Grandview beach access stairs, 20 to 30 feet west of homes on the bluff. A L_{eq} range of 64 to 69 dBA was measured. The high measurements were a result of crashing waves at high tide. There was also noise from youths playing on the beach.

2.8.5.2 Reach 2 – Beacon's Beach to 700 Block Neptune Ave

Noise measurements were made at night for the EIR/EIS for the San Diego Regional Beach Sand Project at the northwest corner of Beacon's Beach Parking lot. The noise range was 58 to 66 dBA. Noise measurements were also made at night on Beacon's Beach access stairs. The noise range at this location was 60-69 dBA.

2.8.5.3 Reach 3 - 700 Block Neptune Ave to Stone Steps

Noise levels would be expected to be similar to the approximately 60 to 69 dBA levels recorded elsewhere along the coastline in the study area. At night and early morning the primary noise source is crashing waves. During the day traffic noise would elevate noise levels.

2.8.5.4 Reach 4- Stone Steps to Moonlight Beach

Noise measurements were made at early morning for the EIR/EIS for the San Diego Regional Beach Sand Project at the foot of A Street. The noise levels ranged from 62 to 67 dBA.

2.8.5.5 Reach 5 - Moonlight Beach to Swami's

Noise measurements were made at early morning for the EIR/EIS for the San Diego Regional Beach Sand Project at the east side of Moonlight Lane and on the D Street stairs 40 feet above the beach. The noise at the first location was 54 dBA because the bluff shields the location from the surf below. The noise range at the second location was 64 to 68 dBA.

2.8.5.6 Reach 6 – Swami's to San Elijo Lagoon Entrance

Noise levels would be similar to the approximately 60 to 69 dBA levels recorded elsewhere in the study area. At night and early morning the primary noise would be crashing surf. During the day traffic noise would contribute to noise levels.

2.8.5.7 Reach 7 - San Elijo Lagoon to Table Tops

Measurements were made in late morning for the EIR/EIS for the San Diego Regional Beach Sand Project from the Chart House restaurant near the San Elijo Lagoon entrance. A noise level of 68 dBA was recorded at the west end of the parking lot on the south side of the Chart House. Loud noises included highway noise and the voices of restaurant staff. The measured noise level just inside the outdoor dining area was 64 dBA.

2.8.5.8 Reach 8 - Table Tops to Fletcher Cove

Measurement NR-1 was near the coast at the northern border of Reach 8. Single-family residential units are located immediately to the south along Circle Drive overlooking the beach area. The daytime L_{eq} at this site was 56.6 dBA. Noises consisted of the sound of waves crashing on the beach, passing traffic along Highway 101, aircraft overflights including a helicopter flyover, and birdcalls.

2.8.5.9 Reach 9 - Fletcher Cove to Solana Beach Southern City Boundary

No noise measurements are available for this reach but night noise levels would be similar to the approximately 60 to 69 dBA levels recorded elsewhere in the project area. At night and early morning the primary noise would be crashing surf. During the day traffic noise would contribute to noise levels.

2.9 Socio-Economic Factors

2.9.1 Population

Approximately 60-percent of Californians live in Southern California, a distribution that has not changed significantly in the past four decades. Almost 75-percent of Californians live in the coastal regions, with the inland-dwelling proportion increasing steadily over the past 3 decades. The 2000 Census reported that the San Diego region (San Diego and Imperial Counties) of southern California maintains a population roughly equivalent to the State of Iowa within a land area (8,375 square miles) that is approximately the size of Massachusetts.

As a result of recession in the early 1990s, the population of California experienced a massive emigration and the slowest recorded population growth for any decade. The domestic migration exodus consisted mainly of people leaving the South Coast region (Los Angeles, Orange, and Ventura Counties), although the phenomena was the same in the San Diego region. All of the state's regions are growing; however, the sources of population growth differ within each region. International migration was especially strong in the South Coast and San Diego (San Diego and Imperial Counties) regions. Components of population change between 1990 and 1999 in the San Diego region consisted of: births (445,000), deaths (170,000), natural increase (275,000), net international migration (164,000), and net domestic migration (-160,000).

The population of San Diego County in 2000 comprised 8-percent of the population of California; the county population was 2,813,833 and the State population was 33,871,648. As shown in Table 2-7, the county experienced a net population increase of almost 13-percent between 1990 and 2000. This rate of growth is slightly below the rate for California as a whole (13.8%) and the United States (13.2%) during the same time period. Using the U.S. Bureau of Economic Analysis projection data for the State of California, the state is expected to experience a population increase of more than 28-percent by 2025, a considerably faster rate of growth than the United States (23%).

Table 2-7 Comparative Population Data (1980 to 2025)

	1980	**1990**	**2000**	**2025****	**% Change (1990-2000)**
Encinitas	n/a*	55,386	58,014	74,679	4.7%
Solana Beach	12,250	12,962	12,979	16,707	0.1%
San Diego County	1,861,846	2,498,016	2,813,833	3,622,147	12.6%
California	23,667,764	29,760,021	33,871,648	43,601,763	13.8%
United States	226,549,000	248,709,873	281,421,906	344,683,537	13.2%

* Encinitas was not an incorporated municipality on January 1, 1980.

**Projections based on Bureau of Economic Analysis rates of growth. 1980 to 2000 estimates obtained from U.S. Census Bureau data.

The City of Encinitas was not incorporated in 1980, but has experienced an absolute growth of over 2,600 persons between 1990 and 2005. The City of Solana Beach has continued to grow during the 1990s, but at a slower rate than the 1980s, consistent with the demographic trend throughout California. The median age of the population of Solana Beach is 41.6 years and the median age in Encinitas is 37.9 years. San Diego County's median age is 33.2 years, and the median age for California is 33.3 years. Solana Beach has an unusually high percentage of the population above age 65 (17%), compared to Encinitas (10%), and the State of California (11%).

The population of the City of Encinitas is 89.3-percent white. Minority populations include: Asian (4.2%); American Indian & Alaskan Native (1%); African American (0.9%); Native Hawaiian (0.3%); and other (7.4%). Approximately 30-percent of the population is of Hispanic or Latino heritage. There are 22,830 households and the average household size is 2.52 persons.

The population of the City of Solana Beach is 89.5-percent white. Minority populations include: Asian (4.4%); American Indian & Alaskan Native (1%); African American (0.7%); Native Hawaiian (0.3%); and other (7.1%). Approximately 30-percent of the population is of Hispanic or Latino heritage. There are 5,754 households and the average household size is 2.25 persons.

Employment

Table 2-8 indicates the predominant sectors of employment for residents of the study area, according to the Profile of Selected Economic Characteristics: 2000 published by the U.S. Census Bureau. As shown in the table, the service industry is important in all regions associated with the study area. The service industry includes: information; professional, scientific, management, administrative and waste management services; educational, health and social services; arts, entertainment, recreation, accommodation and food services; public administration; and other services.

Table 2-8 Employment by Industry, (2000)

Industry	Encinitas	Solana Beach	San Diego County	California
All-Industry Total	31,399	6,902	1,241,258	14,718,928
Farming & Mining	265	21	8,604	282,717
Construction	2,105	284	82,281	915,023
Manufacturing	2,739	536	136,486	1,930,141
Wholesale & Retail Trade	4,704	717	180,100	2,237,552
Transportation & warehousing, and utilities	866	170	47,610	689,387
Finance, insurance & real estate	2,461	809	88,285	1,016,916
Services	18,259	4,365	697,892	7,647,192

2.3.3Income

Table 2-9 summarizes pertinent information regarding income and effective buying power by household in the study area. Approximately 75-percent of county workers are listed as private wage and salary workers. Government workers comprise another 16-percent while another 8.7-percent are self-employed in non-incorporated businesses. Less than one-percent (0.3%) is classified as unpaid family workers. Slightly more than 12-percent of the county population was living below the poverty level in 1999. As shown in Table 2-9, the per capita income and median household income in both study area municipalities are substantially higher than figures for the county and state.

Table 2-9 Income Levels by Household, 1999

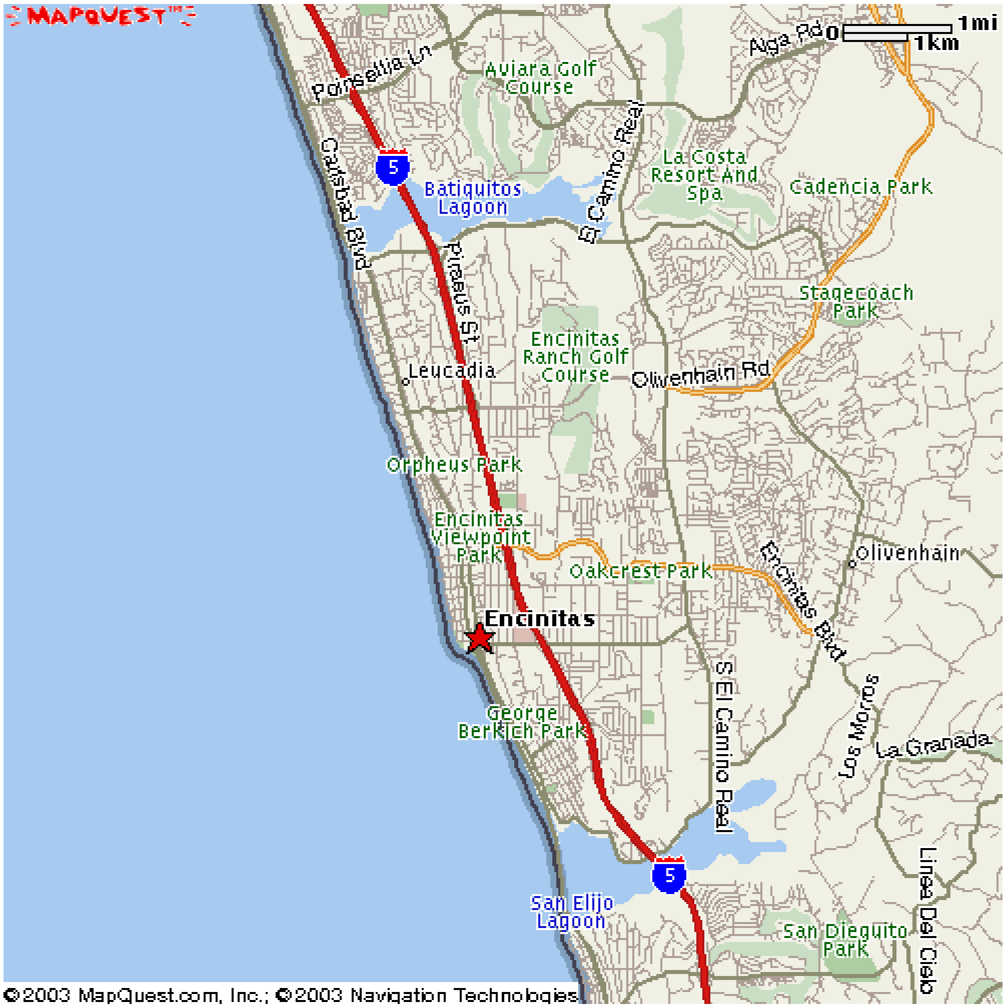
Income Distribution	Encinitas	Solana Beach	San Diego County	California
Total Households	22,970	5,736	995,492	11,512,020
Less than $15,000	1,699	461	124,436	1,615,869
$15,000 – $24,999	1,977	513	117,642	1,318,246
$25,000 - $34,999	2,010	459	122,297	1,315,085
$35,000 – $49,999	3,077	574	159,617	1,745,961
$50,000 - $74,999	4,418	932	200,299	2,202,873
$75,000 or more	9,789	2,797	271,201	3,313,986
Median Household Income	$63,954	$71,774	$47,067	$47,493
Per Capita Income	$34,336	$48,547	$22,926	$22,711

2.9.2 Transportation

Several transportation corridors traverse the Cities of Encinitas and Solana Beach and the County of San Diego providing access to these cities and the shoreline. Primary transportation corridors include Interstate 5, State Highways (101) and major local streets with interconnections to the highways. In addition to the several major roadway corridors, rail service is provided in both the Cities of Encinitas and Solana Beach through the North County Transit Rail “Coaster” and AMTRAK rail-passenger service “Pacific Surfliner.”

The reason for focusing on these roadways is that project-related traffic could be expected to access the coastline and/or the San Elijo Lagoon via these routes. The majority of the remaining roadways in these areas are undesignated local streets. **Figure 2-19** shows the main transportation arteries in the study area.

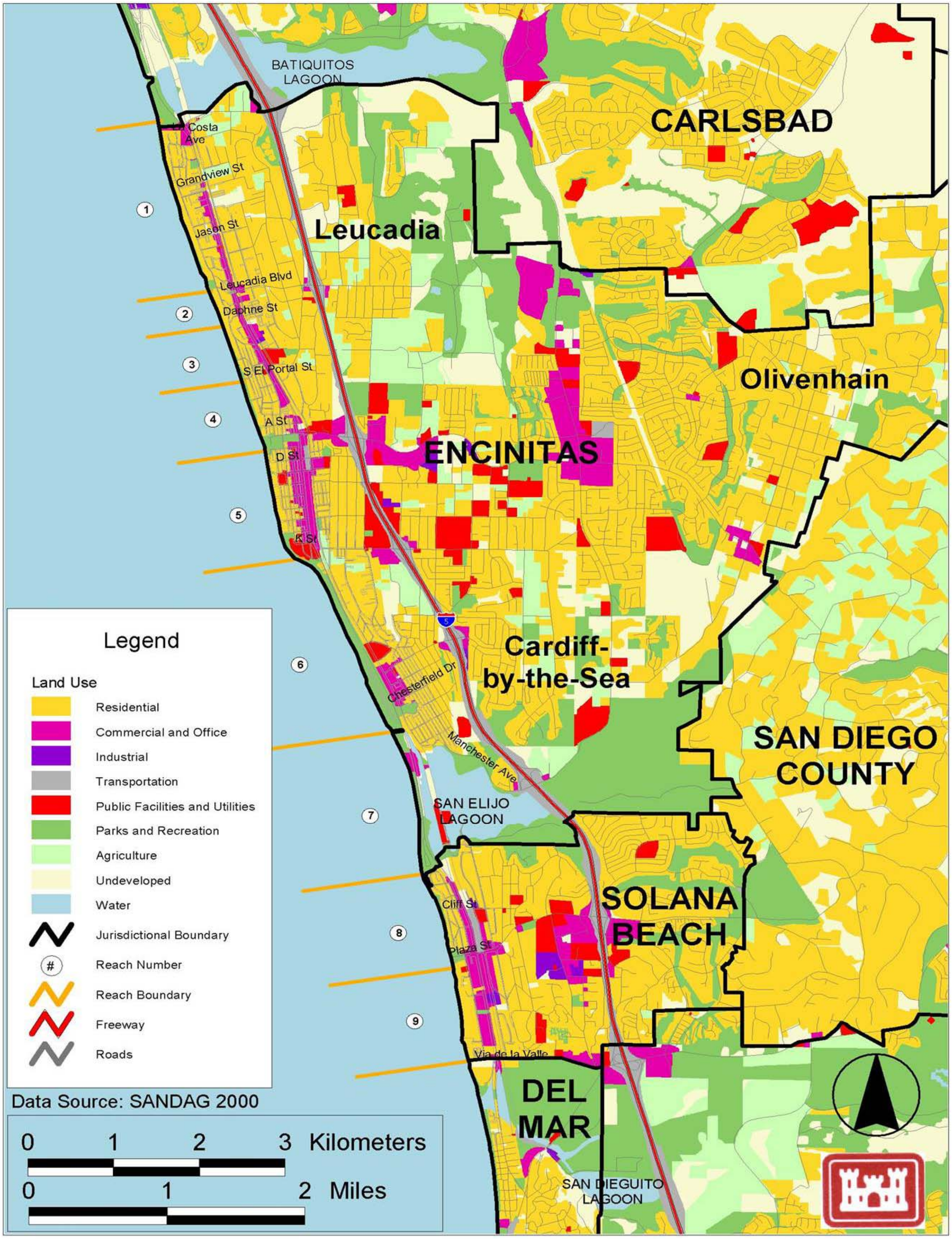
FIGURE 2-19. MAIN TRANSPORTATION ROUTES



2.9.3 Land Use

The study area includes the coastline of the Cities of Encinitas and Solana Beach and the boundary of the San Elijo Lagoon. Surrounding land uses to the lagoon are located within the Cities of Encinitas and Solana Beach and an area of unincorporated San Diego County. State and local land use policies regarding shoreline protection and San Elijo Lagoon are briefly discussed below. More detailed land use information can be found in the EIS. **Figure 2-20** shows land use in the study area with reach boundaries marked on the shoreline.

FIGURE 2-20 LAND USE



2.9.3.1 City of Encinitas

The City of Encinitas was incorporated in 1986 and encompasses an area of approximately 19.56 square miles or 12,516 acres (City of Encinitas 2001). Existing (1995) land uses are dominated by residential, recreational, and agricultural land uses, and public facilities.

The City is divided into five separate communities. Two of these communities, Cardiff-by-the-Sea and Olivenhain include the San Elijo Lagoon, which is the southern most boundary of the City. The lagoon consists of some 1,066 acres owned and managed by the State of California, County of San Diego, and the San Elijo Lagoon Conservancy (**Table 2-10**). The lagoon is designated as ecological reserve/open space/parks in the City's General Plan.

Table 2-10. Existing Land Use Within the City of Encinitas 1995

Land Use	Acres	Percent[1]
Developed Acres	10,692	86.3%
Low Density Single Family	774	6.2%
Single Family	3,332	26.9%
Multiple Family	473	3.8%
Mobile Homes	52	0.4%
Other Residential	6	<0.1%
Industrial	63	0.5%
Commercial/Services[2]	468	3.8%
Office	45	0.4%
Schools	117	0.9%
Roads and Freeways	1,935	15.6%
Agricultural Extractive	1,392	11.2%
Parks and Military Use	1,975	15.9%
Vacant Developable Acres	985	7.9%
Low Density Single Family	319	2.6%
Single Family	509	4.1%
Multiple Family	22	0.2%
Industrial	4	<0.1%
Commercial/Services	113	0.9%
Office	14	0.1%
Schools	0	0%
Future Roads and Freeways	3	<0.1%
Constrained Acres	718	5.8%

Source: SANDAG 2020 Cities/County Forecast
[1] Percentage based upon SANDAG total acres of 12,396. Percentages may not total 100% due to rounding.
[2] Includes public facilities uses

2.9.3.2 City of Solana Beach

The City is comprised of approximately 2,193 acres (SANDAG 2002b) with approximately 3.5 miles along the Pacific Ocean coastline (City of Solana Beach, 1999). The City of Encinitas and the San Elijo Lagoon, which is partially within the city, border Solana Beach to the north. The unincorporated County of San Diego borders the City on the east. To the south, the City is bounded by the Cities of Del Mar and San Diego.

Solana Beach has been extensively developed and has little vacant developable land remaining. Existing land uses with the City of Solana Beach are shown in **Table 2-11** and **Figure 2-20**. Land uses are governed by the City's General Plan adopted in 1986 and amended through November 22, 2001. The predominant land uses within the City are residential, which comprise approximately 54% of the total land area. Recreational and open space land uses comprise approximately 12% of the land area and commercial uses comprise approximately 13%. The predominant commercial uses are located along Highway 101 and Lomas Santa Fe Drive. Other business-related uses such as office/professional and light industrial comprise approximately 3% of the total land area. The northern portion of the City borders the San Elijo Lagoon and consists of primarily single family residential development (SANDAG 2000b). Coastline areas include Fletcher Cove and North Seascape Surf Beach Parks.

Table 2-11. Existing Land Use Within the City of Solana Beach 1995

Land Use	Acres	Percent[1]
Developed Acres	2,140	98%
Low Density Single Family	0	0%
Single Family	957	44%
Multiple Family	218	10%
Mobile Homes	1	<0.1%
Other Residential	0	0%
Industrial	28	1%
Commercial/Services[2]	288	13%
Office	41	2%
Schools	66	3%
Roads and Freeways	471	21%
Agricultural Extractive	0	0%
Parks and Military Use	70	3%
Vacant Developable Acres	39	2%
Low Density Single Family	0	0%
Single Family	18	1%
Multiple Family	2	0.1%
Industrial	11	1%
Commercial/Services	3	0.1%
Office	4	0.2%
Schools	0	0%
Future Roads and Freeways	0	0%
Constrained Acres	14	1%

Source: SANDAG 2020 Cities/County Forecast
[1] Percentage based upon SANDAG total acres of 2,193. Percentages may not total 100% due to rounding.
[2] Includes public facilities uses.

2.9.3.3 San Diego County - Unincorporated

An unincorporated area of San Diego County lies to the east of the San Elijo Lagoon. The area is part of the San Dieguito Community of the San Diego County General Plan. This area is comprised of a number of homeowners associations and other residentially subdivided land located between the Cities of Solana Beach, Encinitas, San Diego, and the covenant area of the Rancho Santa Fe Association (County of San Diego 1996). In 1985, the area was purposely excluded from incorporation as part of Solana Beach because residents felt that they had more in common with the inland rural areas to the east (County of San Diego 1996). The area currently consists of spaced rural development, agricultural uses, and undeveloped land (SANDAG 2000b). Residential development includes primarily large estate homes.

2.9.3.4 Land Use Summary by Study Area Reach

Reach 1 – Batiquitos Lagoon to Beacon's Beach

Leucadia State Beach is located within Reach 1. Land use along the buffs is residential. Public parking areas are located at the northern and southern ends of Reach 1. A storm drain occurs at the beach at Grandview Street.

Reach 2 – Beacon's Beach to 700 Block Neptune Ave

Leucadia State Beach extends into Reach 2. Bluff top land uses are primarily residential.

Reach 3 - 700 Block Neptune Ave to Stone Steps

Reach 3 includes Encinitas Beach County Park. Adjacent land uses are primarily residential.

Reach 4 - Stone Steps to Moonlight Beach

Land uses in Reach 4 include Seaside Gardens Park and a parking area at the northern end of Moonlight State Beach. Adjacent land uses are primarily residential. Five storm drains occur at Moonlight Beach, three convey flows from Cottonwood Creek, and two are from residential neighborhoods. These storm drains discharge from the bluff face at an elevation above the design berm elevation. Therefore no relocation of the storm drains is anticipated.

Reach 5 - Moonlight Beach to Swami's

Reach 5 includes Moonlight State Beach. Land use on the bluffs is primarily residential. Two parks on the bluffs, H Street and I Street Viewpoint Parks, provide public access and viewing areas on the bluffs. The Self Realization Fellowship Center, a meditation and religious center, is located at the southern end of Reach 5.

Reach 6 – Swami's to San Elijo Lagoon Entrance

Reach 6 includes San Elijo State Beach and Cardiff State Beach. Adjacent land uses include park areas at Seacliff Park and San Elijo State Beach. These parks provide parking and visitor facilities such as restrooms and picnic tables. A 171-unit campground is located adjacent to the beach at San Elijo State Beach. Two storm drains occur at Swami's Beach, one pipe drains between Swami's and San Elijo State Beach, and one pipe drains at the north end of the State Beach.

Reach 7- San Elijo Lagoon to Table Tops

Reach 7 includes Cardiff State Beach. Cardiff State Beach includes parking lots and visitor facilities at the north and south ends of the beach. Restaurant Row is adjacent to the beach at the north end of Reach 7, south of the opening to San Elijo Lagoon.

Reach 8 - Table Tops to Fletcher Cove

Reach 8 includes Tide Beach Park and the parking area for Fletcher Cove Beach Park. Adjacent land uses on the buffs are primarily residential.

Reach 9 - Fletcher Cove to Solana Beach Southern City Boundary

Reach 9 includes Fletcher Cove Beach Park and North Seascape Surf Beach Park. Residential development occupies the top of the bluffs. One storm drain occurs at Fletcher Cove and another drain occurs at Seascape. These storm drains discharge from the bluff face at an elevation above the design berm elevation. Therefore no relocation of the storm drains is anticipated.

2.9.4 Regulatory Setting

A complete listing and discussion of all applicable Federal and State Environmental regulations can be found in the EIS. The sections below cover only those laws, policies, and regulations that have a major impact on defining the problems and needs or formulating and evaluating alternative plans.

2.9.4.1Endangered Species Act/ National Environmental Policy Act of 1969 (NEPA)

The Endangered Species Act (MEC) NEPA requires federal agencies to consider environmental consequences and project alternatives before a decision is made to implement a federal project. The Council on Environmental Quality (CEQ) was established under NEPA, and in 1978 issued *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act* (40 Code of Federal Regulations [C.F.R.] §§ 1500-1508). The attached EIS/EIR is the first part of a document being prepared in accordance with these regulations.

2.9.4.2 California Coastal Act (1972 Coastal Zone Mgmt Act (CZMA) and 1976 California Coastal Act)

The CZMA requires that federal activities must be consistent with the enforceable policies of the approved state coastal program to the maximum extent practicable. The California Coastal Act authorizes the California Coastal Commission (CCC) to implement the CZMA. The implementing regulations for the CZMA are described in 15 C.F.R. 930, and the policies pertinent to coastal consistency determinations are included in California Public Resources Code (Sections 30200-30365.5). These regulations require that the CCC prepare a consistency determination for all federal projects that could affect the coastal zone.
Sections 30235, 30233, and 30707 of the Coastal Act focus on protection of ***existing*** structures and protection of public beaches in danger of erosion. Under these sections, construction including revetments, breakwaters, groins, may be permitted to save a structure in imminent danger, and dredging of open coastal waters, lakes, wetlands, and other areas may be permitted only where less environmentally damaging alternatives are not feasible or where dredging and spoil disposal are for restoration purposes. The definition of "existing structure" has never been established in court, however, and is construed by some to mean existing at the time the Coastal Act was adopted (1976), and by some to mean existing at the present moment.

The Coastal Act requires that new construction (Section 30253) not require its own protective devices for erosion control. The California Coastal Commission is attempting to limit the number of emergency permits they must grant for new protective devices. The intent is to force owners to build away from the shoreline.

Construction of structures for bluff protection is generally permitted when an existing structure is endangered and no other means of protecting that structure is available. In general, seacave plugging and filling are preferred to seawalls, revetments, and other large coastal structures.

2.9.4.3 Local Ordinances and Policies – Solana Beach

The City of Encinitas and City of Solana Beach are within the Coastal Zone covered by these laws, and as such are required to implement a Local Coastal Program (LCP) consisting of a coastal Land Use Plan (LUP) and implementing ordinances. The LCP issues and policies are included in the General Plans of the City of Encinitas and City of Solana Beach (City of Encinitas 1995, City of Solana Beach 2001). Current local policies encourage replenishing beaches with sand in order to protect coastal bluffs from erosion (although there is no funded program to do so on a regular basis).

In addition, in 1994, the City Council of Solana Beach, after approximately eleven public meetings and/or workshops, embraced a strategy of establishing goals and procedures by adopting the Shoreline and Coastal Bluff Protection Ordinance. This approximately 5,200-word policy document establishes guidelines, expectations, findings and procedures related to sea caves, seawalls, maintenance and other shoreline and coastal bluff issues. The ordinance functions ". . .to create a regulatory framework which balances the protection of vested private property rights and important public interests in shoreline resources which can be harmed by the construction of coastal bluff protection measures." The Codes encourage preventive measures such as filling of seacaves and notches only when needed, and discourage the construction of seawalls.

The ordinance provides some degree of local control over permitting coastal protection structures. The City council is currently reviewing this ordinance for possible revision or repeal. Full repeal would result in all permit review authority (and liability) reverting to the Coastal Commission, with minimal City control.

The City of Solana Beach also identifies goals and policies regarding shoreline protection in Chapter 17.62 of the Municipal Code. Excerpts from that code are presented below.

10B *Preservation and enhancement of the beach is an important city goal. The city will also support regional efforts to manage beach sand.*

20 *Permits for the construction of seawalls, revetments, bluff retaining walls, gunite coverings, metal or wood armoring and other similar structures will be issued only when necessary to accomplish one of the following purposes:*

1.To protect existing legally built structures,
2. To preserve economically viable use of property, and
3. To abate a public nuisance.

The City of Solana Beach General Plan specifies the following goals relative to protection of aesthetic resources (City of Solana Beach 2001):

Goal 3.2: Protect and enhance sensitive open space areas and viewsheds.

The Open Space and Conservation Element of the General Plan lists the following objectives and policies relative to protection of visual access and vista points:

Objective 1.0: Preserve existing open spaces at appropriate locations throughout the city.

Policy 1a. The city shall restrict development along the bluffs overlooking Solana Beach and other areas … to those uses which retain the open space character of these areas …in accordance with the open space plan.

Policy 1b: The city shall ensure the preservation of existing public beaches, parks, trails, open space areas, and golf courses pursuant to the adopted land use element of this general plan.

Policy 1c: The city shall implement the objectives and policies established in the community design element of the general plan which promote the preservation and enhancement of open space features.

Objective 2.0: Preserve the city's hillside areas and natural landforms in their present state to the greatest extent possible.

Policy 2.1 enacts a hillside development ordinance that encourages development standards to: 1) maintain the natural visual character of the hillsides to the maximum feasible extent, … 3) preserve significant visual and environmental elements, … 8) encourage the use of innovative structural designs which adapt to natural topography, … and 10) require the blending of colors and materials with the hillside environment.

Objective 3.0: Maintain the quality of scenic views in the city as well as the overall visual quality of the city's landscape.

Policy 3.a. The city shall require new developments to be subject to visual impact analyses where potential impacts upon sensitive locations are identified.

Policy 3.b: The city shall require that new structures and improvements be integrated with the surrounding environment to the greatest extent possible.

2.9.4.4 Local Ordinances and Policies – Encinitas

The City of Encinitas Local Coastal Program (LCP) was effectively certified by the California Coastal Commission on May 11, 1995 and the City assumed Coastal Permit authority on May 15, 1995. The City's LCP has two parts -- a Land Use Plan (LUP) and an Implementation Plan. The Land Use Plan includes issues and policies related to the requirements of the Coastal Act. Because the majority of the City lies within the boundaries of the Coastal Zone, the Land Use Plan has been included within the City's General Plan, creating a combined document.

The City's jurisdiction over coastal devleopment permits does not include tidelands, submerged lands and public trust lands. The Coastal Commission has appeal authority within the above mentioned areas.

In addition, the City adopted resolution 2002-04 to address aesthetic concerns of coastal structures. The overall intent of this policy is to have a bluff preemptive measure
designed to appear as a natural feature consistent and compatibe with the adjacent natural bluff in both color and form.

The specific pertinent sections of the City's Local Coastal Plan are given below:

8.6.1 *The city will encourage measures which would replenish sandy beaches in order to protect coastal bluffs from wave action and maintain beach recreational resources. The city shall consider the needs of surf-related recreational activities prior to implementation of such measures.*

10.3 *The city shall explore the prevention of beach sand erosion. Beaches shall be artificially nourished with excavated sand whenever suitable material becomes available through excavation or dredging, in conjunction with the development of a consistent and approved project. The city shall obtain necessary permits to be able to utilize available beach replenishment sands (as necessary, permits from the Army Corps of Engineers, California Coastal Commission, Department of Fish and Game, USEPA, etc.).*

The City of Encinitas General Plan also specifies the following goal relative to protection of aesthetic resources (City of Encinitas 1995):

Goal 9: Preserve the existence of present natural open spaces, slopes, bluffs, lagoon areas, and maintain the sense of spaciousness and semirural living within the I-5 View Corridor and within other view corridors, scenic highways and vista/view sheds as identified in the Resource Management Element (Coastal Act/30240/30251).

The Resource Management Element of the General Plan lists the following goals and policies relative to protection of visual access and vista points:

Goal 4: The City, with the assistance of the State, Federal and Regional Agencies, shall provide the maximum visual access to coastal and inland views through the acquisition and development of a system of coastal and inland vista points (Coastal Act/30251).

Goal 8: The City will undertake programs to ensure that the Coastal Areas are maintained and remain safe and scenic for both residents and wildlife (Coastal Act/30240).

2.9.4.5 California State Lands Commission

The California State Lands Commission (CSLC) has jurisdiction over all of California's tide and submerged lands and the beds of naturally navigable rivers and lakes, which lands are sovereign lands, and swamp and overflow lands and State School Lands, which are proprietary lands. The CSLC has statutory authority to approve appropriate uses of state lands under its jurisdiction and has oversight responsibility for tide and submerged lands legislatively granted in trust to local jurisdictions (Public Resources Code § 6301).

2.9.4.6 Geological Hazard Abatement District (GHAD)

Bluff-top homeowners in the City of Solana Beach are exploring the formation of a Geological Hazard Abatement District to deal with the issue of coastal bluff erosion. Such districts are formed to raise money to control hazards such as landslides and bluff collapses. The City of Solana Beach received a proposal from the Beach and Bluff Conservancy to consider establishing a GHAD. An independent third-party review of the proposal has been prepared and is on the City's website for review and comment. The district would act as a miniature state agency, able to levy assessments, impose bonds, borrow money and accept government grants. Districts can buy, lease or acquire land through eminent domain, and can generate money for bluff management and shield the city from lawsuits resulting from collapses. Creation of the district would also devolve some permitting power from the city to the district for such things as sea wall construction.

A preliminary independent analysis of the issues associated with the possible formation, financing, and operation of a GHAD concludes "…it appears that formation of the GHAD may be a viable and productive component of the City's overall shoreline and coastal bluff management strategy." At the time this document was prepared, the proposal to form the district is under public review.

2.9.4.7 Sand Mitigation Fee

Several years ago, the California Coastal Commission established a sand mitigation fee program as a condition for permitting seawalls and seacave notch fills. A very detailed formula was prepared which estimates the dollar value of sand expected to be lost from the beach due to these protective structures. Although the scientific community has widely varying opinions of the impacts of shoreline structures on beach morphology, this formula has been formally adopted by the State. Funds collected by the Coastal Commission are accredited to each municipality and are administered by SANDAG for utilization by and within each corresponding municipality. Approximately $300,000 in such funds have been collected by the Coastal Commission from projects within Solana Beach alone. Much of these funds are still available for use within the established SANDAG and Coastal Commission criteria and procedures. State and federal standards require at least a roughly proportional relationship between the estimated sediment lost and the amount of fees collected.

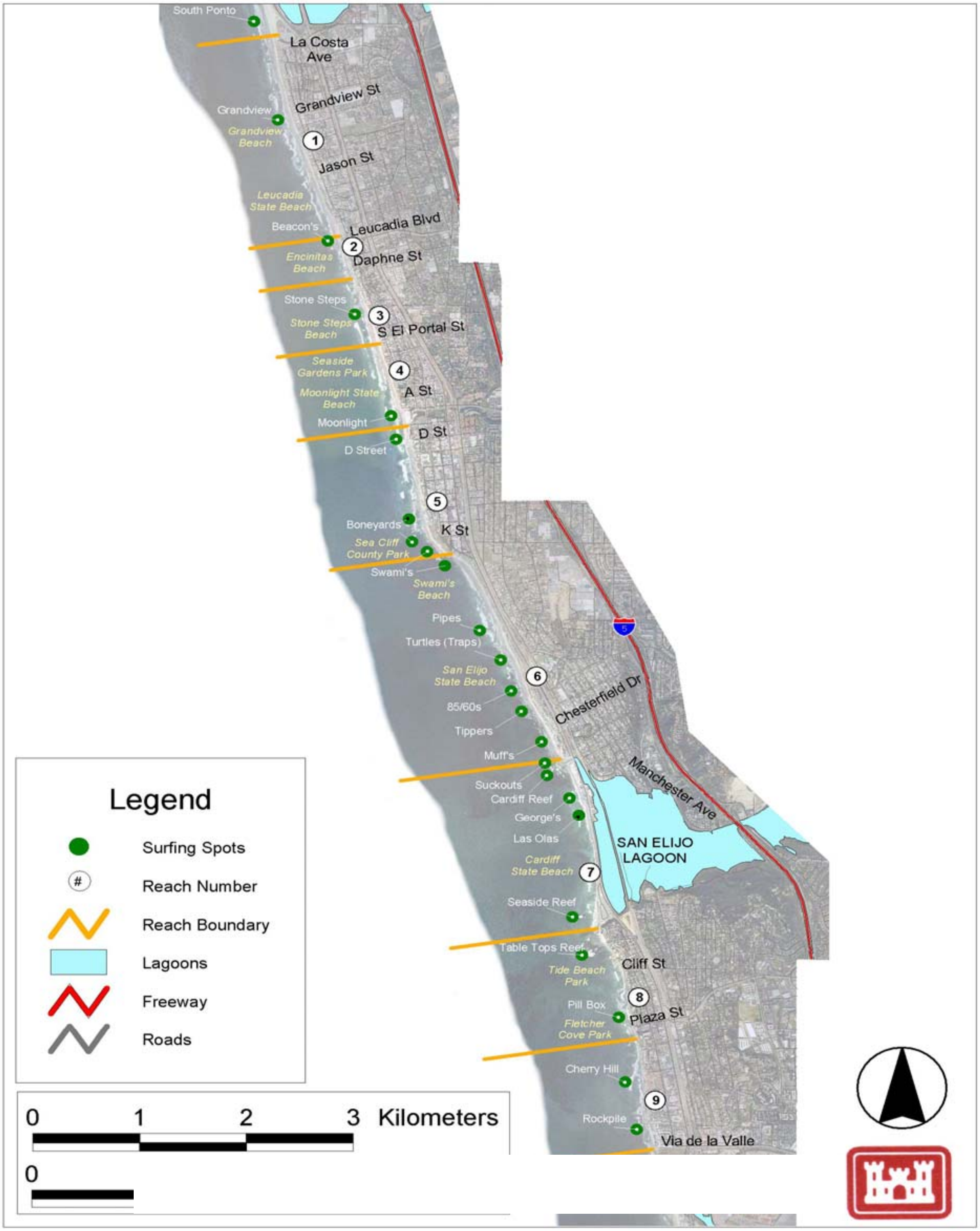
2.9.4.8 Pending State Legislation

AB947 - In 2003, Assembly Member Hanna-Beth Jackson authored a new Bill AB 947, which would implement the state's draft erosion policy. Most recently, the California Resources Agency issued the "Draft Review of California Coastal Erosion Planning and Response: A Strategy for Action," which proposes a more formalized plan for planned retreat with the construction of hard protection devices only when all other "options have been considered and deemed to be infeasible." To date, this policy has never been adopted.

2.9.5 Recreation

The project area provides a variety of coastal-oriented recreational activities including beachgoing, surfing, fishing, skin and SCUBA diving, and nature study. Recreational opportunities are facilitated by a series of state, county, and local parks in the project area that provide access to the beach. Many of these so-called parks exist on the beach area itself. Residential properties exist atop the bluff behind the beach. Typically, the beach park is accessed by a public stairway that leads to the beach from the blufftop. Numerous private staircases also provide access for bluff top residents. The local shoreline is known as one of the best surfing areas on the West Coast. Parks and popular surfing spots are shown on **Figure 2-21**.

FIGURE 2-21. RECREATIONAL OPPORTUNITIES



Recreational use of the shoreline is affected by the narrow beaches under baseline conditions. Wave run-up limits access along the shore during high tides. Cobble and exposed sandstone in some reaches limit the amount of space on which beach goers can sunbathe and picnic.

Recreational safety is provided by lifeguard services. The California Department of Parks and Recreation provide lifeguards at the state beaches, and the cities of Encinitas and Solana Beach provide lifeguards at beaches within their jurisdiction.

Water pollution stemming from storm drain outlets and from the outlets of coastal lagoons has resulted in occasional closing of beaches to protect public recreational safety. Bacteria indicators are monitored at the storm drain outlets and adjacent surfzone and in the surfzone offshore coastal lagoons. Elevated bacteria concentrations have been measured on occasion in the surfzone at Moonlight Beach near the outlet of Cottonwood Creek, at Cardiff State Beach near the outlet of San Elijo Lagoon, and offshore storm drain locations at San Elijo State Park and Fletcher Cove. The elevated concentrations generally occur during rainy periods, and then quickly dissipate from mixing associated with tidal action and longshore currents. On occasion the beach closures have been due to sewage spills.

2.9.5.1 California State Parks

Four California State Parks are located along the coastline of the City of Encinitas. At the north end of the City is Leucadia State Beach (also known as Beacon's). Leucadia State Beach is currently operated by the City of Encinitas on behalf of California Department of Parks and Recreation (P. Zentner, personal communication, 2002). Swimming, surfing, fishing and picnicking are popular at this small, rocky beach (California Department of Parks and Recreation 2002). Access to the beach access is via an improved trail at the foot of Leucadia Boulevard. There are no recreational facilities that would distinguish this beach area as a park except a beach access trail. A small parking lot offering free parking is located along Leucadia Boulevard.

Moonlight State Beach is located at the end of Encinitas Boulevard. This beach offers swimming, surfing and fishing. Facilities include volleyball and tennis courts, recreational equipment rentals, and a snack bar. As with Leucadia State Beach, Moonlight State Beach is operated by the City of Encinitas on behalf of the California Department of Parks and Recreation (P. Zentner, personal communication, 2002).

San Elijo State Beach is located north of the San Elijo Lagoon inlet channel in the community of Cardiff-by-the-Sea. This beach includes approximately 17 hectares (42 acres) with 2,193 meters (7,190 feet) of ocean frontage and is more developed than Cardiff State Beach (SANDAG 2000a). Its facilities include a 171-campground with five comfort stations, an 86-space day use parking lot, a unit office, an entrance station, a concessions building, a lifeguard tower, informal campground center, and six beach access stairways. San Elijo State Beach is a popular camping spot and offers swimming, surfing and picnicking (California Department of Parks and Recreation 2002). The narrow, bluff-backed stretch of sand has a nearby reef popular with snorklers and divers. San Elijo State Beach had approximately 766,100 visitors in the 2001-2002 season (C. Sullivan, personal communication, 2002).

Cardiff State Beach is located south of San Elijo Lagoon's inlet channel and west of the lagoon. The facility encompasses approximately 10 hectares (25 acres) and has 1,998 meters (6,550 feet) of ocean frontage from Cardiff Reef south to Seaside Reef (SANDAG 2000a). The California Department of Recreation recorded approximately 1,189,445 visitors at Cardiff State Beach during the 2001-2002 season (C. Sullivan, personal communication, 2002). Cardiff State Beach includes two parking lots (at the north and south ends of the beach), restrooms, and an emergency vehicle access ramp. Recreational opportunities include swimming, surfing and beachcombing (California Department of Parks and Recreation 2002a).

2.9.5.2 County Parks

Three county parks are located within the study area. The San Elijo Lagoon County Park and Ecological Reserve encompasses approximately 405 hectares (1,000 acres) of diverse habitat in and surrounding the lagoon. There are over 8 kilometers (5 miles) of hiking trails in the reserve open to the public. A Nature Center is located on the northwest side of the lagoon off Manchester Avenue. Facilities include a parking lot, restrooms, drinking water, and a one-mile loop trail.

Encinitas Beach County Park is located north of Stone Steps Beach in the City of Encinitas. Free street parking is available at Stone Steps Beach. The beach is open from 5 a.m. to 2 a.m. and is popular for surfing (San Diego Online 2002). South of Cardiff State Beach, in the City of Solana Beach, is Tide Beach County Park. The park is frequented by naturalists who visit the large reef and tide pools that extend from Tide Beach Park north to Table Tops found at the beach (San Diego North Convention & Visitors Bureau 2001). Parking is available along local streets next to the park. Similar to Leucadia State Beach, no recreational facilities exist in either of these County Parks.

2.9.5.3 Local Parks

Several city-managed beaches/parks are located along the coastline of the Cities of Encinitas and Solana Beach. Stone Steps, in the City of Encinitas is a long stairway that leads down to a rocky beach that is popular with surfers, swimmers and fishermen (San Diego North Convention & Visitors Bureau 2001). There is limited street parking near the beach. Further south is Swami's Beach, located north of San Elijo State Beach. Large waves make this beach renowned by surfers. The beach offers a picnic area with restrooms and free parking at the top of the cliff overlooking the beach.

Two addition local parks are located within the City of Solana Beach. Fletcher Cove Beach Park is located at the end of Plaza Street and offers activities such as volleyball, shuffleboard and basketball. Park facilities include restrooms, showers, and picnic tables (San Diego North Convention & Visitors Bureau 2001). Near the south end of the City, is North Seascape Surf Beach Park. This is basically just a beach access point that does not include any park facilities. There is parking along South Sierra Avenue and on nearby side streets.

2.9.5.4 Recreation Summary by Study Reach

Reach 1 – Batiquitos Lagoon to Beacon's Beach

Reach 1 includes Leucadia State Beach. It can be accessed from the north via a parking lot off Highway 101 at the northern boundary of the reach near the terminus of La Costa Avenue. A fenced off dune area adjacent to this parking lot provides opportunities for nature study. A lifeguard tower is located at the base of the public stairway at the end of Grandview Street near the middle of the reach. From the south, the beach in Reach 1 can be accessed from a bluff parking lot and trail near the foot of Leucadia Boulevard (Beacon's). Grandview and Beacon's are popular surfing spots.

Reach 2 - Beacon's Beach to 700 Block Neptune Ave

Reach 2 includes Encinitas Beach. Public access in this reach is via the parking lot and trail at the foot of Leucadia Boulevard at the northern end of the reach. Beacon's is a popular surfing spot. Extensive reefs provide tidepooling, fishing, and diving opportunities.

Reach 3 - 700 Block Neptune Ave to Stone Steps

Stone Steps Beach is located in Reach 3. It can be accessed from a public stairway. Stone Steps is a popular spot for surfing and fishing. Parking at this location is along Neptune Street.

Reach 4 - Stone Steps to Moonlight Beach

Reach 4 includes Seaside Gardens Park and Moonlight State Beach. The reach can be accessed from the north at the stairway at Stone Steps. Reach 4 also can be accessed from the south through the Moonlight State Beach parking area at B Street near the foot of Encinitas Boulevard. Lifeguard towers are at the north and south ends of Moonlight Beach. Moonlight Beach includes various amenities including restrooms, showers, a snack bar, and picnic tables. Park facilities also include volleyball, fire rings, and equipment rental. Moonlight Beach is a popular beach for surfing, beachgoing, surf fishing and SCUBA diving.

Reach 5 - Moonlight Beach to Swami's

Access to this reach is provided by a parking lot and stairway at D Street. Viewing areas are provided at small parks at H and I streets. The Self Realization Fellowship Center, at the southern end of the reach, has a blufftop trail that is open to the public. D Street and Boneyards are popular surf breaks along this reach. The southern portion of this reach includes reefs and surfbreaks that are part of the Swami's surfing area. The rocky intertidal in the southern end of the reach provides opportunities for tidepooling, fishing, and skin and SCUBA diving. The southern portion of the reach can be accessed by the parking lot and public staircase at Seacliff County Park in Reach 6.

Reach 6 – Swami's to San Elijo Lagoon Entrance

Swami's is an extremely popular surfing area. The reefs at Swami's are also popular with SCUBA divers, fishermen and tidepoolers. Access is provided via a parking area and park (Seacliff Park) on top of the bluffs. This park includes picnic tables, barbecue grills, and restrooms. San Elijo State Beach stretches along most of Reach 6. San Elijo State Beach facilities include a campground, restrooms, a day use parking lot, a concessions building, an information center, and six beach access stairways. Nature exhibits are at the park headquarters. Popular surfing spots along San Elijo State Beach include Pipes, Turtles (Traps), 85/60s, Tippers, and Muff's. Extensive reefs provide opportunities for tidepooling, fishing, and skin and SCUBA diving.

Reach 7 - San Elijo Lagoon to Table Tops

Cardiff State Beach is located south of the lagoon inlet in this reach. Facilities include restrooms, picnic tables, and public parking lots at the north and south ends of the beach. Lifeguard towers are located south of the lagoon mouth and south of the restaurants. Suckouts, Cardiff Reef, George's, and Seaside Reef are popular surfing spots. Cardiff and Seaside Reefs also are popular tidepool, fishing, and skin and SCUBA diving spots. Restaurant Row, south of the lagoon inlet, includes several popular restaurants with ocean views.

Reach 8 - Table Tops to Fletcher Cove

Tide Beach County Park and Fletcher Cove County Park are located within Reach 8. Tide Beach Park can be accessed by a stairway down the bluffs. Reefs occur at the north end of the reach at Table Tops and to a lesser extent at Tide Beach Park. Table Tops is a popular tidepool, fishing, skin and SCUBA diving, and surfing spot. Access to these reefs and Tide Beach Park also is available from the north end of the reach from the parking area at the south end of Cardiff State Beach. They also can be accessed from the south starting at Fletcher Cove. The Fletcher Cove Park can be accessed from a parking area at Plaza Drive near the foot of Lomas Santa Fe Drive, which is located at the south end of Reach 8. A lifeguard tower is located at Fletcher Cove. Offshore reefs provide opportunities for skin and SCUBA diving. Popular surf breaks in this reach include Table Tops and Pill Box. Off the beach, Fletcher Cove Park includes restrooms, showers, picnic tables, shuffleboard, basketball, and volleyball.

Reach 9 - Fletcher Cove to Solana Beach Southern City Boundary

Primary access to this area is from the Fletcher Cove Park parking area to the north. Stairways to the beach are located at North Seascape Surf Beach Park, near the middle of the reach, and Del Mar Shores near the south end of the reach. A lifeguard tower is located at Seascape Surf. Popular surfing spots within Reach 9 include Cherry Hill and Rockpile. Offshore reefs provide opportunities for skin and SCUBA diving and fishing.

2.9.5.5 Beach Access- Encinitas

The shoreline within the boundary of the City of Encinitas can be accessed through several Beach Access points throughout the city's shoreline. These beach access points include Grandview Beach, Beacons, Stone Steps, Moonlight, D street, Swami's Beach, San Elijo and Cardiff. Beach access points are located within a quarter mile at least from any point on the beach. Figure xx shows the beach access points within the City of Encinitas.

2.9.5.6 Beach Access- Solana Beach

Similar to the City of Encinitas, beach access points for the City of Solana Beach are located within at least a quarter mile from any point along the beach. Thse beach access points include, Tide Park, Fletcher Cove, Seascape Surf, and Del Mar Shores Terrace. Figure xx shows beach access points for Solana Beach.

2.9.5.7 Beach Attendance Estimates

Beach attendance estimates are compiled by the State for Cardiff State Beach and San Elijo State Beach and by the two cities for local beaches. Beach attendance counts are typically based upon parking lot use or upon periodic head counts at the beach. Beach use from un-monitored access points are typically under represented in beach attendance statistics, therefore, the beach attendance estimates presented below represent a conservative estimate of beach use. Beach use can vary widely from year to year based upon beach characteristics, rainfall, facility construction and maintenance, etc. **Table 2-12** shows beach attendance estimates by jurisdiction for 1996 – 2002. The beach attendance figures presented in the table are subject to review and revision. The Cities are currently initiating further studies of beach attendance using more scientific methods to get more accurate data. This data will be incorporated into the Feasibility Study as it becomes available.

Table 2-12. Beach Attendance by Jurisdiction 1996-2002

Year	San Elijo State Beach	Cardiff State Beach	City of Encinitas	City of Solana Bch	Total
1996	565,436	1,124,344	1,811,615	764,330	4,265,725
1997	439,090	953,528	1,467,079	618,968	3,478,665
1998	372,017	381,127	923,161	389,487	2,065,792
1999	346,387	368,274	869,607	366,892	1,951,160
2000	572,903	1,453,953	2,071,430	873,947	4,972,233
2001	870,137	1,676,654	2,747,705	1,159,271	6,453,768
2002	766,100	1,189,445	2,204,287	930,000	5,089,832

Beach attendance fell in 1998 and 1999 but has significantly increased since then. Average total beach attendance from 1996 to 2002 was 4,039,596, however, average attendance from 2000-to-2002 was 5,505,278, an increase of 36%. Beach attendance is always subject to fluctuation from year to year, but it is apparent from the general timing and trends that the SANDAG beach nourishment project coincided with a significant increase in beach visitation.

Figure xx- Beach Access- City of Encinitas

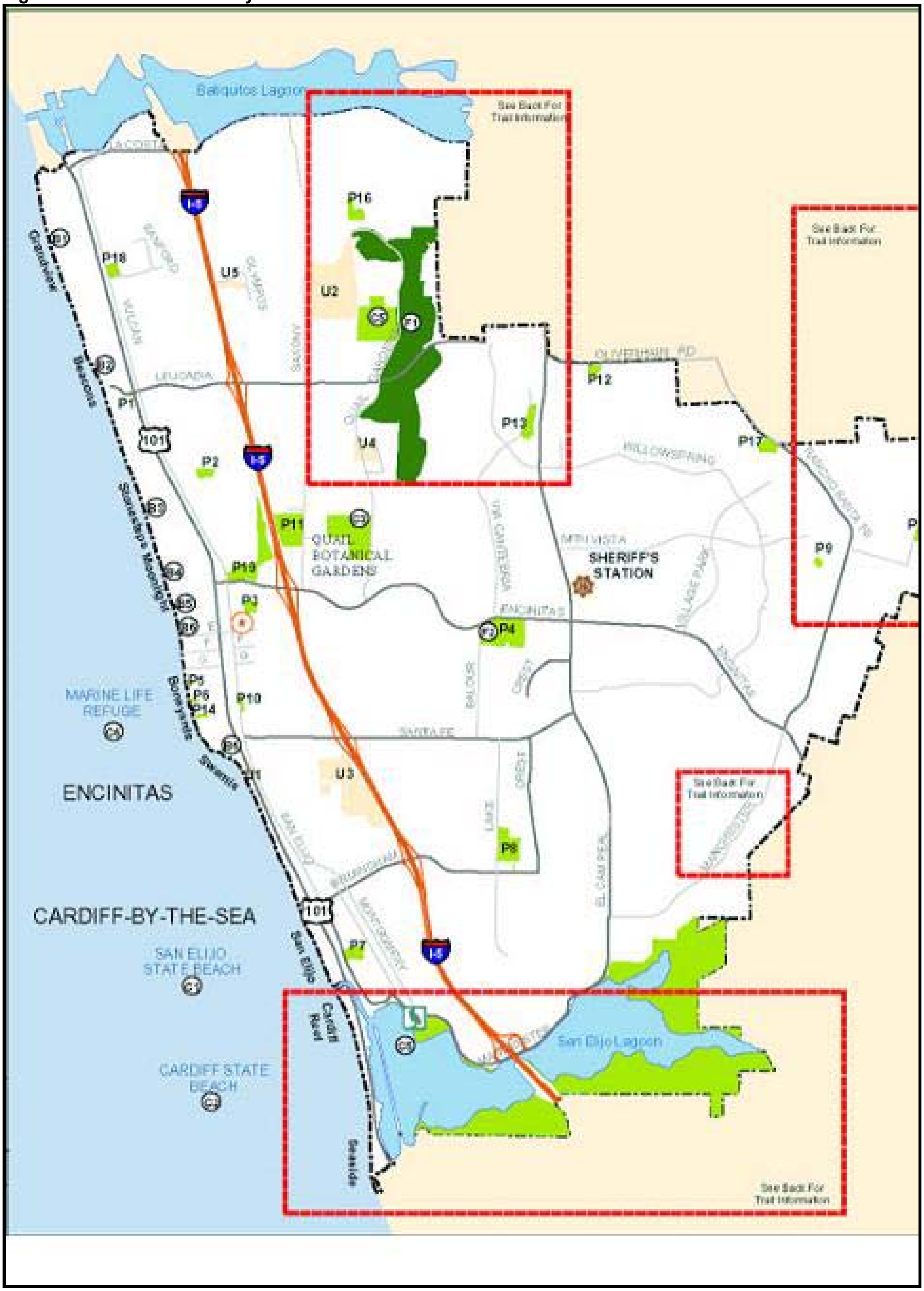
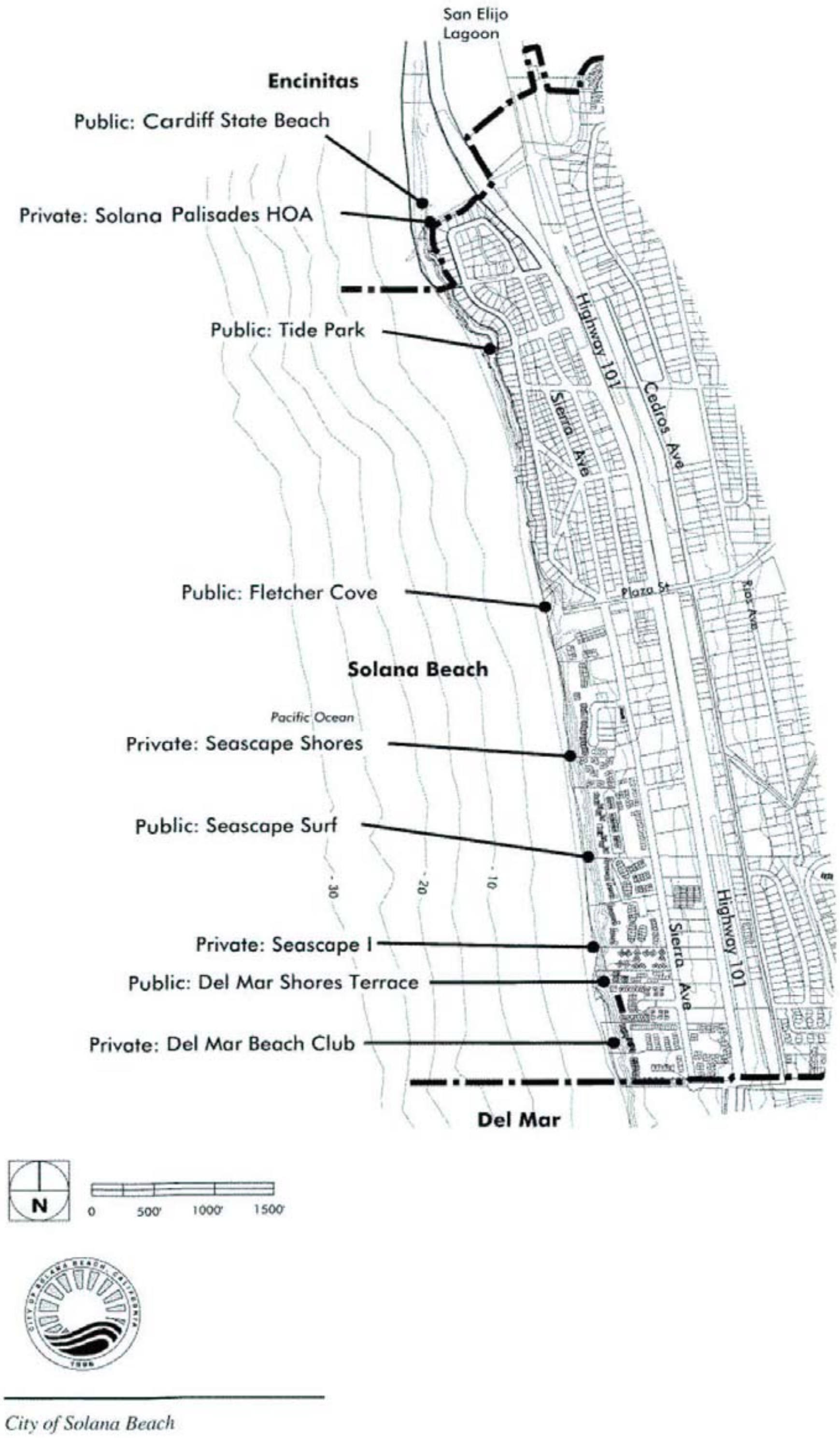


Figure xx- Beach Access, City of Solana Beach



Chapter 3. Problems and Needs

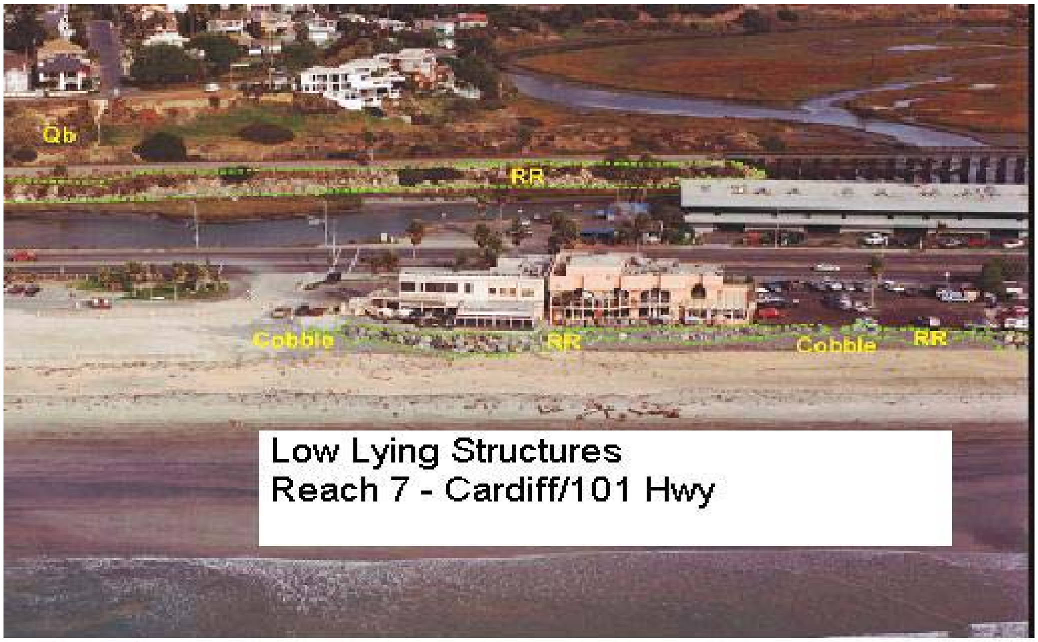
3.1 Statement of the Problem

In the last 10 to 15 years, The Solana Beach-Encinitas shoreline has experienced accelerated erosion of the beaches and coastal bluffs. Since the late 1970s and early 1980s, Southern California has experienced a series of unusual weather patterns when compared to the rest of this century. Fluvial delivery has also been significantly reduced due to river damming and inland sand mining activities. The cumulative effects of these impacts have produced erosion of the once-wide, sandy beaches. As a result of the severe winter storms in the 1982-1983 El Nino year and the extreme storm of 1988, most of the thin sand lens on the Encinitas beaches was lost even prior to the 1997-1998 El Nino season. Within Solana Beach, the chronically denuded beach condition was also worsened after the 1997-1998 season. It is apparent that beach sands were stripped away and lost from the littoral system during that season. With the loss of the wide sandy beaches, storm waves attack the toe of the bluff and eventually form a notch. As the notch depth increases, it eventually triggers an upper bluff failure. The timing of these failures are difficult to predict and often occur several months after the storms have passed. As a result, damages occur to bluff top structures when bluffs collapse (Reaches 1 - 5, 8 and 9), and also to private structures and public infrastructure subject to direct wave attack in low-lying areas (Reach 7). The loss of beach has also severely degraded recreational value in all reaches, and the loss of beach combined with the undercutting bluff erosion creates dangerous overhangs which constitute a serious public safety issue. There have been two fatalities in recent years caused by sudden bluff collapse in the study area and adjacent beaches. The problems and needs are discussed below by problem type and reach. Reach 7 is discussed first because the damage categories and mechanisms are different from all other reaches.

3.1.1 Beach Erosion and Flooding at Cardiff/Highway 101 (Reach 7)

It is anticipated that without periodic artificial nourishment, the Encinitas and Solana Beach beaches will remain depleted for the foreseeable future (throughout the 50 year period of analysis). In Cardiff, (Reach 7) on the low-lying sand spit between the ocean and San Elijo Lagoon, the restaurants will continue to be vulnerable to coastal flooding and storm damage, and Hwy 101 will continue to be flooded and closed periodically. The photograph on **Figure 3-1**, shows typical flooding along Reach 7. . There is also concern over a complete undermining and failure of Hwy 101 in this area, but rock revetments have thus far prevented this from occuring. This section of Hwy 101 is designated part of the Strategic Highway Network (STRAHNET) by the U.S. Dept. of Defense, and loss of the highway could impact defense readiness.

FIGURE 3-1. CARDIFF-HWY 101



3.1.2 Beach Erosion and Bluff Retreat (Reaches 1 – 6, 8 and 9)

The denuded beaches provide little or no protection to the bluff toe. Waves during coastal storms will continue to attack the bluff toe. Accelerated bluff toe erosion will likely occur in the absence of protective structures or beach sands throughout the study area. **Figure 3-2** shows waves attacking the toe of the bluff during a winter storm**. Figure 3-3** shows a bluff failure causing severe structural damage in Encinitas in 1996.

The impending threat of bluff failure has forced many private homeowners on the blufftop to build seawalls to protect the bluff toe. A permit is required from the California Coastal Commission (CCC) to build any shore protection structures. Although the CCC has discretion over granting normal permits, it is effectively forced to grant emergency permits if the applicant meets normal requirements and can demonstrate “imminent” damage to his home. A few normal permits for seawalls have been granted in the past, but most owners prefer to wait until damage to their home is “imminent” so the CCC is more likely to grant them an emergency permit. Costs for a seawall to protect a typical residential property can exceed $250,000, including the necessary studies, reports, and permits.

3.1.3 Beach Erosion and Recreation (All Reaches)

Beach recreational use is directly related to beach width. Not only does beach erosion decrease available “towel space” but it also cuts off access to other “pocket” beaches that are accessible only by walking along the shoreline. Even if these pocket beaches do not erode away, loss of adjacent beach means that there is no access to them except at lower tides or on calmer days.

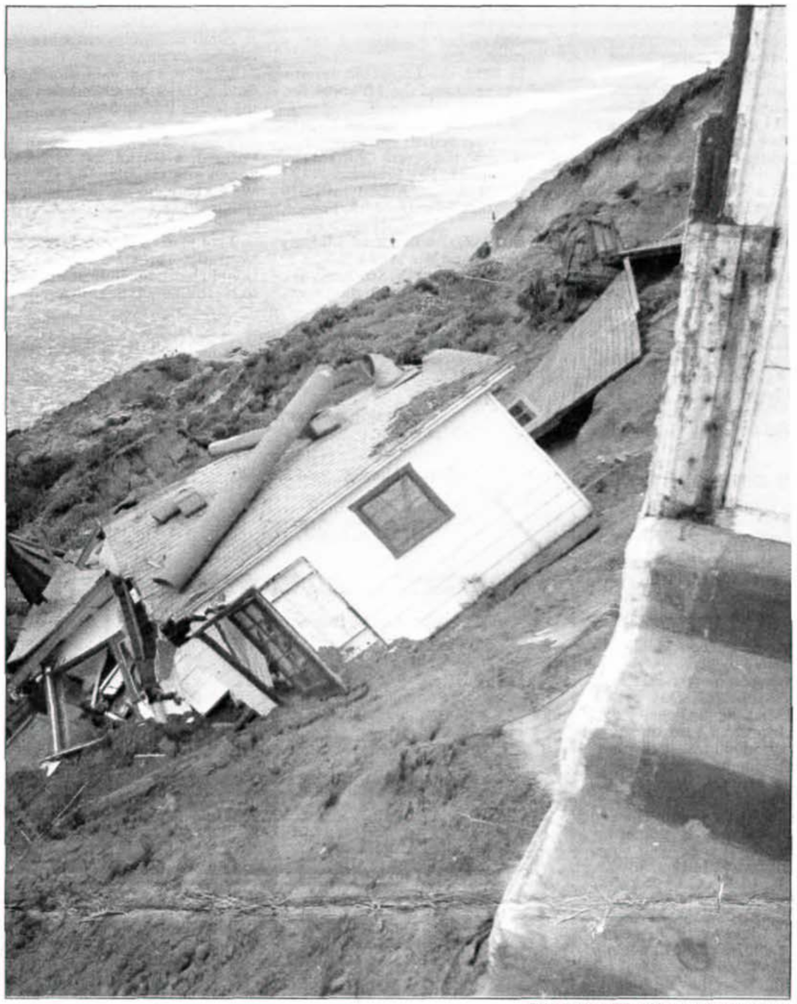
3.1.4 Bluff Retreat and Public Safety (All Reaches)

Erosion of the bluff toe occurs at the base of the bluff where waves impact, and results in a “notch” at the base of the bluff anywhere from one to twenty feet deep in places. When this notch reach a sufficient depth, the weight of the overhanging bluff exceeds the cohesive support of the soil, and the bluff collapses without warning. Due to the nature of soil cementation and stress factors, these failures usually occur when the soil is drying out in the summer months, when there is little rainfall or wave activity but more people crowded onto the narrow strip of eroded beach. This combination of high recreational user density and spontaneous catastrophic failure has resulted in at least two fatalities in the last few years when people on the beach were crushed by sudden bluff collapses. Although in the past there has been sufficient warning to evacuate structures on the blufftop before they were undermined and collapsed onto the beach, the potential exists for loss of life in this scenario, also, if the bluff failure is large enough and occurs without warning.

In addition, in Reach 7, loss of the beach often forces pedestrians to walk on the rubble or on the Hwy, creating hazardous conditions.

FIGURE 3-2 WAVE ATTACK DURING COASTAL STORM

FIGURE 3-3. BLUFF FAILURE DAMAGE



BILL WECHTER / NORTH COUNTY TIMES

A room from the house at 828 Neptune Ave. in Leucadia lies on the side of the coastal bluff Monday.

SOURCE: THE OCEANSIDE NORTH COUNTY TIMES - Tues., June 4, 1996

NEPTUNE AVE, ENCINITAS
1996

Photo 1

3.2 Historical Damages and Impacts

3.2.1 Beach Erosion and Flooding – (Reach 7 Cardiff/Highway 101)

Damages caused by wave run-up occur along the low-lying section of the study area at Cardiff State Beach (Reach 7). Coastal storms generate damages in this reach when storm waves overtop Old Highway 101 and the revetments that protect three restaurants located west of Old Highway 101. During severe storms, waves wash small rocks and cobbles onto Hwy 101, which must be closed until it is cleared. Highway 101 was closed 41 times between 1988 and 1997, for an average duration of 5.6 hours per event.

Damages in this reach are categorized as clean-up costs (including removal of debris from Old Highway 101 and clean-up costs to the three restaurant interiors after a storm), damage costs to the three restaurants, and traffic delay costs that are incurred when Old Highway 101 is closed due to debris in the roadway and clean up operations.

Due to the nearshore bathymmetry in Reach 7, big waves may not cause significant damage if peak waves approach the shoreline during low tides. The water level depends upon the eroded beach profile, the tide level and wave-induced setup, which is proportional to wave height. Therefore the probability of a storm event occuring during a high tide is taken into account.

3.2.2 Beach Erosion and Bluff Retreat (Reaches 1 - 6, 8 and 9)

Beach and bluff erosion have been ongoing problems in both Encinitas and Solana Beach. As the beaches narrow, sensitive sandstone bluffs are exposed to crashing waves, which carve notches into the bluffs. The overhanging areas above the notches are then prone to collapse. This has prompted property owners atop the bluffs to armor or otherwise try to protect their property before structural damage occurs. Approximately half of the shoreline in the study area has been modified with some type of bluff protection structure, at significant cost.

Seawall costs were obtained from a survey of actual costs from recent projects in the study area. Some private seawalls have been constructed in the past to include upper bluff stabilization. These are massive structures that armor the bluff from the base to the top. These structures are extremely costly and have received strong opposition from special interest groups. Therefore, most private seawalls are designed to protect only the toe of the bluff assuming that once the toe is protected, only minor residual erosion will occur until the bluff achieves a stable angle of repose. These seawalls are designed with the assumption that there will be little to no protective beach during the winter when most of the severe storms occur. Therefore they are constructed to withstand heavy wave attack. Most private seawalls in the study area are built at an elevation of +15 feet with a toe elevation of -2 feet MLLW. In May 2005, local contractors were consulted to obtain actual construction estimates. For an average seawall, the in-place cost, including texturization and coloring, was estimated to be roughly $175 per facial square foot. Assuming the average toe elevation of -2 feet, and a 17-foot height, the construction cost would be about $150,000 per 50-foot lot. Engineering and design fees historically run $20,000 to $60,000 per lot. Plan check fees are about $10,350, with a $10,000 access ramp fee, $40,000 in legal fees, and a $20,000 Sand Mitigation Fee.

A total cost of $2,975 per linear foot was assumed as an average for seawall construction costs. In addition $120,000 is assumed to be the associated cost per seawall for Engineering and design, permit and plan check fees, legal fees, beach access ramp fees, and sand mitigation fees. Total cost for a 50-foot lot averages $270,000.

Bluff failure records, including photos, newspaper articles, and city staff logs were examined for the entire study area since 1990 and over 193 significant events were recorded. Although the maximum single bluff retreat was almost 9 meters in depth, most of the failures had a depth of 0.8 to 3.2 meters. The Coastal Engineering Appendix contains a complete listing of bluff failures used in the database, however, major collapses over the past few years are listed below in **Table 3-1**, and typical large bluff failures are shown in **Figures 3-4 and 3-5**.

Table 3-1. Recent Major Study Area Bluff Failures	
Jun 1996	A portion of a house in Leucadia was destroyed when an unstable sea cliff collapsed. Additional properties adjacent to the damaged home also were placed at risk and in need of emergency stabilization measures.
Jan 2000	A woman sitting on the beach was killed in a bluff collapse in Leucadia.
Jan 2001	Four bluff-top homes in Leucadia (south of Beacon's Beach) were deemed unsafe by the City of Encinitas due to unstable and cracked bluffs. Large rocks were piled at the base of the bluffs to protect the cliffs from the current large surf and extreme tides.
Feb 2001	A bluff collapse destroyed a portion of the trail at Beacon's Beach off Neptune Avenue in Leucadia.
May 2001	Part of a Solana Beach property fell away when a bluff gave way as a neighbor was trying to reinforce it by driving steel pilings the bluff. A concrete slab, part of a patio extension the neighbor was building, slid down toward the shore, taking with it a workman who had been standing on it. The bluff collapse also claimed part of an additional adjacent yard and rendered a portion of the house unsafe for occupancy. Owners of the three parcels obtained an emergency permit to build a 100-foot long, 35-foot high seawall to shore up the base of the bluff, estimated to cost roughly $400,000.
Jul 2002	A man camping overnight in a small cave at South Carlsbad State Beach was killed when a portion of a bluff collapsed.
Jul 2002	About 80 tons of sandstone, rocks and boulders fell onto the beach as a 75 foot wide by 12 feet high section of bluff collapsed just south of Fletcher Cove Park. The collapse was the largest in a series of smaller bluff collapses along the study area.

Date of Report	Latitude/Longitude	Location	Brief Description
8/5/2002	Lat: N 32 59.716 Long: W 117 16.538	325/327 Pacific	Major bluff failure, 20 cu. yd., concrete patio overhanging bluff
8/27/2002	Lat: N 32 59.513 Long: W 117 16.470	N. side of Fletcher cove	Major bluff failure of approximately 185 cu yds, active debris fall, below community center
8/29/2002	Lat: N 32 59.906 Long: W 117 16.640	523/525 Pacific	Major mid bluff failure, approx 15'W X 8'H X 5'D of aluvium
9/6/2002	Lat: N 32 59.473 Long: W 117 16.453	S. Fletcher Cove	Major bluff failure below sunbathing area, approx 3 cu. yd.
9/19/2002	Lat: N 32 59.495 Long: W 117 16.471	Fletcher Cove Dissipater	Major bluff failure approx 4 cu. yd. boulders, alluvium, iceplant debris
10/29/2002	Lat: N 32 59.369 Long: W 117 16.465	Surfsong Condos at 205-245 S. Sierra	Major bluff failure, 5 cu. yd. Continuation of failure which occurred 1/1/02
11/7/2002	Lat: N 32 59.896 Long: W 117 16.622	521 Pacific	Major bluff failure, approx. 20 cu. yd. of debris
11/1/2002	Lat: N 32 59.369 Long: W 117 16.465	Surfsong Condos at 205-245 Sierra	Continuing failure which occurred 1/1/02 approx 5 cu. yd.
11/1/2002	Lat: N 32 59.753 Long: W 117 16.544	347 Pacific	Major Linear lower bluff failure, approx. 6 cu. yd.

11/7/2002	Lat: N 32 59.896 Long: W 117 16.622	521 Pacific	Major, approx. 20 cu. Yd. Lower bluff, potention threat
11/7/2002	Lat: N 32 59.791 Long: W 117 16.561	371 Pacific	Major bluff failure 10 cu. yd. mid/upper bluff. Continuation of already badly eroded area
11/26/2002	Lat: N 32 59.711 Long: W 117 16.533	325 Pacific	Major bluff failure 10 cu. yd. earthen debris and concrete, posts, concrete footings and other wooden retaining devices precarious. Continuation of already badly eroded area.
1/29/2003	Lat: N 32 59.934 Long: W 117 16.622	523/525 Pacific	3 cu. yd. in and around existing sea cave plug, large portion of bluff un-supported and in danger of collapse.
2/6/2003	Lat: N 32 59.292 Long: W 117 16.445	Surfsong Condos at 205-245 Sierra	Major failure south of failure reported 1-19-03, 3 cu. yd. of solid sandstone composition, debris and boulders.
2/6/2003	Lat: N 32 59.507 Long: W 117 16.471	Fletcher Cove	2 failures in close proximity N. side. 7 and 6 cu. yd. respectively.
2/25/2003	Lat: N 32 58.991 Long: W 117 16.387	Seascape I Condos	Major failure, just north of Seascape I, 96 cu. yd.
3/5/2003	Lat: N 32 59.423 Long: W 117 16.474	Las Brisas Condos at 135 S. Sierra	Major failure S. of Cove below Las Brisas approx 100' X 72" x 35' adjacent to existing sea cave plug
11/4/2003	Lat: N 32 59 511 Long: W 117 16.469	N. side of Fletcher Cove	Major failure N. of cove, water flowing mid-bluff, report from Geosoils
3/1/2004	Lat: N 32 59.348 Long: W 117 16.435	Surfsong Condos at 205-245 Sierra	Major, upper and lower bluff failure over 2 cu. yd., dangling posts/rope
6/16/2004	Lat: N 32 59.779 Long: W 117 16.551	50' N. of Scism Seawall	Minor, potential threat, no immediate problem
6/14/2004	Lat: N 32 59.779 Long: W 117 16.551	Scism Seawall	Major, potential threat from overhang patio. Signs posted. Geosoils evaluating all.
6/28/2004	Lat: N 32 59.759 Long: W 117 16.551	Scism Seawall	Major and minor failures, approx. 15' X 6' X 4' south of seawall

FIGURE 3-4. LARGE BLUFF FAILURE

FIGURE 3-5. LARGE BLUFF FAILURE

3.2.3 Recreation (All Reaches)

Recreation opportunities and experiences have been severely degraded due to loss of beach sand, as illustrated in **Table 3- 2**, which contains estimates of beach attendance before and after the SANDAG Beach Nourishment Project, which was started in 2000 and completed in 2002. Significant increases in attendance in 2000 are due to commencement of the SANDAG project, resulting in some wider beaches and greater public awareness of the resource.

Table 3-2. Estimated Beach Attendance

Year	San Elijo State Beach	Cardiff State Beach	City of Encinitas	City of Solana Bch	Total
1996	565,436	1,124,344	1,811,615	764,330	4,265,725
1997	439,090	953,528	1,467,079	618,968	3,478,665
1998	372,017	381,127	923,161	389,487	2,065,792
1999	346,387	368,274	869,607	366,892	1,951,160
2000	572,903	1,453,953	2,071,430	873,947	4,972,233
2001	870,137	1,676,654	2,747,705	1,159,271	6,453,768
2002	766,100	1,189,445	2,204,287	930,000	5,089,832

3.2.4 Bluff Retreat and Public Safety (Reaches 1 – 6, 8 and 9)

In addition to many close calls, there have been four fatalities in recent years in the region due to coastal bluff collapses;

- January, 1995, two people were killed and one injured in a bluff collapse at Torrey Pines State Reserve a few miles south of the study area.

- January, 2000, a citizen of Encinitas was killed when a large section of bluff collapsed in the City of Encinitas (study area)

- July 2002, a man was killed a few miles north of the study area at South Carlsbad State Beach by a similar bluff collapse.

3.3 Future Without Project Conditions and Assumptions

More detailed discussion and examples of these assumptions and all future without project (FWOP) economic conditions may be found in the Economics Appendix. Only those assumptions and conditions having a direct impact on project formulation are listed below.

50 Year Project Life

The time period associated with the future without project analysis was assumed to be 50 years from Project Year 0 (first year of full project benefits).

Continued Lagoon Maintenance Dredging

Under the Future Without Project, no significant beach replenishment activities would occur within the vicinity *except* those associated with routinely authorized maintenance dredging (i.e., Oceanside sand bypass, Agua Hedionda Lagoon maintenance dredging, Batiquitos Lagoon maintenance dredging, and San Elijo Lagoon entrance maintenance). However, as discussed in the Coastal Engineering Appendix and in Chapter 1 of this Main Report, these dredging events are too small, too rare, or too far away to have any significant long term impact on shoreline erosion in the study area.

No Sand on Beach

There is a history of beach fill projects within the study area. Most significantly, in 2001, The San Diego Association of Governments (SANDAG) constructed a Regional Beach Sand Replenishment Project that placed 1.6 million cubic meters (2.1 million cubic yards) of beach sand on twelve San Diego County beaches. Five of the beaches were located within the study area; In Encinitas, four beaches received beach sand; Batiquitos, 118,000 cubic yards; Leucadia, 130,000 cubic yards; Moonlight Beach, 88,000 cubic yards; and Cardiff, 104,000 cubic yards. In Solana Beach, 140,000 cubic yards of beach sand was placed at Fletcher Cove. The total project cost was $17.5 million; of that, approximately $9.6 million of Federal funds were provided by the U.S. Navy as part of their San Diego Harbor Dredging (Homeporting) Project. The remaining funds were provided by the State of California through the Department of Boating and Waterways Beach Nourishment Program.

Recent beach surveys show that the effects of the SANDAG project are currently minimal. This project was designed as a test for a larger regional nourishment program, but no funding is currently available to fund the larger program. No local plans exist or are in the works for another large project of the scale of the SANDAG project. It is reasonable to assume that none will occur in the future without Federal participation. Therefore, under FWOP conditions, beaches will experience minor seasonal fluctuations as a small amount of sand moves onshore and offshore, but in general, denuded conditions will persist.

Private Piecemeal Protection

As discussed in section 1.4.4, homeowners on the blufftop have been building seawalls to protect their property when damage to the structure is imminent. The California Coastal Commission is effectively forced to grant a permit when the structure is in “imminent danger”. Although the regulatory environment is subject to change in the future, there is currently no firm indication of any impending change. Therefore, the FWOP assumes continued piecemeal protection of the bluff toe by private landowners under emergency permits; including maintenance of existing structures.

No Damage Behind Seawalls

It was assumed that structures currently protected by seawalls (over 8 ft. high, usually incorporating steel and/or timber, with tiebacks) would not suffer damages significant enough to affect any plan formulation or selection. The minimum design life of a seawall is 25 to 30 years, and even if damages occurred after that, these future damages, once discounted to present value, would be insignificant.

3.3.1 Reach 7 - Coastal Flooding and Storm Damages – Cardiff-Highway 101

In Reach 7, all damages are related to direct wave attack and flooding during storm events. Based on historic data, a threshold wave run-up elevation was determined above which existing shore protection structures are overtopped, resulting in flooding, structural damages and Hwy 101 closures. A probability was computed for six different storm events of varying return periods, and wave runup elevations were calculated for each. The tidal regime was then superimposed over these elevations to produce probabilities of overtopping for each event, including tidal influence. When the wave runup exceeds the threshold value structural flooding damages, Hwy 101 closure delays, and Hwy 101 clean up costs are all computed and counted as damages. The probabilities for each event are then applied to these damages to compute an average annual expected damage for Reach 7. The following sections describe this methodology in more detail, and a full discussion can be found in the Economics Appendix.

3.3.1.1 Reach 7 - Criteria for Storm Damages – Overtopping Protective Structures

Projections of costs related to closure of Hwy 101 were made based on the probability of different representative tide and storm conditions occurring simultaneously in a given year, then estimating the damages that would occur for a given probability event. These damages are then weighted by their probability and summed up to represent the most likely average annual damages over the project life. This is in compliance with Corps of Engineers guidance and accepted benefit/cost analysis for coastal storm damage. The overtop tide elevation presented in **Table 3-3** is the tide elevation required for overtopping at Old Highway 101 for each return period storm.

Table 3-3 Overtop Tide Elevations

Return Frequency	Overtop Tide Elevation (meters)	Probability of Tide Greater than Overtop Elevation	Probability of Tide Less than Overtop Elevation
2	1.51	0.129	0.871
5	1.43	0.166	0.834
10	1.36	0.198	0.802
25	1.29	0.233	0.767
50	1.23	0.264	0.736
100	1.15	0.313	0.687

3.3.1.2 Restaurant Cleanup and Repair Costs

Restaurant clean up costs consist of the costs of cleaning the interiors and exterior areas of the three restaurants west of Old Highway 101 after storm waves overtop the revetment that protects the restaurants. Interior clean up includes cleaning and/or replacement of water soaked carpets, replacement of ruined furniture, and removal of debris from the parking area. Clean up costs were estimated from interviews with the personnel and management of the three restaurants.

Water levels about two feet above elevation of the parking lot results in limited water damage to carpet in the restaurant. Moderate storms result in the occasional loss of plate glass walls, which shield patio areas, and the restaurants have abandoned using outdoor patio areas, but have left the glass as additional protection for the restaurant windows. Major storms in 1988 and again in 1997 resulted in extensive destruction to the interior of one restaurant, though damage to the kitchen was minimal due to its placement in the building. Discussions with personnel in the other two adjacent restaurants revealed that coastal storms have caused very few problems with damage. Outdoor furnishings are either bolted down or moved in prior to a storm event, and windows are also routinely boarded when storms are expected.

Given these data it was assumed that an overtopping of Highway 101 would result in extensive damage to the restaurants, and that any preventative measures would be insufficient to protect against waves that overtop Highway 101. Damages under an overtopping condition are estimated as shown in **Table 3-4**.

Table 3-4. Damages to the Three Cardiff Restaurants from Major Overtopping Event

Damage Classification	Restored Cost	Cost
Plate-Glass	28.76 per Square Foot	$49,010

Carpeting & Fixtures	12.70 per Square Foot	$275,400
Kitchen	$790 per linear foot	$395,000
Clean-up Costs	$800 per event	$2,400
Total Cost		**$721,810**

3.3.1.3 Roadway Cleanup Costs

Storm waves deposit cobbles and other debris on the roadway and right-of-way that is routinely removed by the City of Encinitas. Partial or full closure of Old Highway 101 to vehicular traffic is often required during clean up operations (traffic delay damages are discussed in the next section). Roadway clean up costs are calculated as the costs incurred by the City of Encinitas in order to remove debris from the roadway after storm wave overtopping of Old Highway 101. Data provided by the City of Encinitas indicate that debris removal operations for events that close Old Highway 101 cost approximately $1,160 in labor, staff, and equipment costs.

3.3.1.4 Traffic Delay Costs

Traffic delays are caused when storm induced wave run-up deposits cobble and debris on the roadway requiring partial or full roadway closure during clean up operations. Roadway closure data provided by the City of Encinitas was compared to historic storm data to correlate roadway closures with the return frequency of storm events. The data indicate that partial roadway closure will result from a two-year storm event and that full roadway closure will result from storms ranging from the five-year to the hundred-year event. Using the man-hour estimates provided by the City of Encinitas and assuming a two-person crew, a partial road closure would last two hours (rounded to the nearest full hour) and a full road closure would last four hours.

Partial closure of the roadway at Old Highway 101 is expected to cause southbound (west side of the roadway) motorists to slow down due to merging traffic. Motorist speed reduction during a partial roadway closure is expected to add one minute to the motorist’s travel time. Full closure of the roadway will cause northbound and southbound motorists to detour through local streets in the City of Encinitas to the San Diego Freeway (Interstate 5) and then back through local streets again to return to Old Highway 101 beyond the closure area. The additional net travel distance attributed to the detour is 6.5 miles. The additional net travel time attributed to the detour is 14 minutes. **Table 3-5** shows the time and distance components of traffic delay damages.

Table 3-5 Time and Distance Components of Traffic Delay Damages

Return Frequency	Roadway Closure	Closure Duration	Additional Travel Time	Additional Travel Distance
2	Partial	2 hours	1 minute	n/a
5	Full	4 hours	14 minutes	6.5 miles
10	Full	4 hours	14 minutes	6.5 miles
25	Full	4 hours	14 minutes	6.5 miles
50	Full	4 hours	14 minutes	6.5 miles
100	Full	4 hours	14 minutes	6.5 miles

Traffic delay damages for each impacted motorist are calculated as the sum of the opportunity cost of the additional time spend driving due to speed reductions or detours and the vehicle operating cost of driving the net additional distance attributed to the detour. The Reconnaissance Report (1995 data) indicated that 9,302 vehicles travel Old Highway 101 southbound daily and 8,890 travel northbound. Increasing those figures by the estimated compound annual population growth (0.42%) for the City of Encinitas from 1990 to 2000 yields 9,621 southbound vehicles and 9,915 northbound vehicles daily in 2003. The duration of a partial closure (two hours) is 8.3% of a day, indicating 798 vehicles would be impacted by a partial closure (9,621 * 0.083 = 798). Similarly, the duration of a full roadway closure (four hours) is 16.7% of a day, indicating 3,256 vehicles would be impacted by a full closure (19,536 * 0.1667 = 3,256).

Opportunity cost of time estimates are based upon the duration of the delay and the estimated annual wage of the motorist. The hourly wage ($33.54) was calculated from the Bureau of the Census 1999 estimate of median family income for the City of Encinitas ($63,954) and adjusted to 2003 dollars using the Bureau of Labor Statistics Inflation Calculator. IWR Report 91-R-12 “Value of Time Saved for Use in Corps Planning Studies” indicates that the hourly opportunity cost for automobile trips delayed less than five minutes (partial closure) depends on the trip purpose and should be valued at 6.4, 1.3, or .1% of the motorist’s hourly wage. Again, depending on the trip purpose (work, social/recreational, or other), for delays greater than five minutes but less than 15 minutes (full closure), the opportunity cost is valued at 32.2, 23.1, or 14.5% of the motorist’s hourly wage. Conducting the calculations indicates that the opportunity cost of time for a partial closure is $.04 per work trip per person ($33.54 * 0.064 * .02 = $.04) and $2.5 per work trip per person ($33.54 * 0.322 * .23 = $2.5) for a full closure. For the other trip purposes, the per person values for full delays are $1.8 and $1.1, and the per person values for a partial delay are $.01 and $.001.

The U.S. Bureau of Transportation Statistics estimates that there are 1.6 persons per vehicle on average. Using this occupancy estimate, and assuming that the trips are distributed evenly between the three purposes, the total opportunity cost of time for a partial roadway closure is $22, and the total for a full roadway closure is $9,352.

The additional vehicle operating cost (cost for fuel, oil, tire wear, etc.) due to the net additional distance traveled during full roadway closures is based upon a unit cost of $0.15 per mile, which was calculated using 2003 expenditures data from the U.S. Bureau of Labor Statistics for residents in the Western U.S. This cost is meant to represent only the variable cost of vehicle operation, and the estimate made here is consistent with a 2003 estimate by the American Automobile Association. The additional cost per vehicle is calculated as $.98 (6.5 * $0.15 = $.98). The total additional vehicle operating cost caused by a full roadway closure is $3,191 (3,256 * $.98 = $3,191). Table 4-4 shows total estimated traffic delay damages for each return period storm.

Table 3-6 Total Traffic Delay Damages

Return Interval	Roadway Closure	Delay Time Cost	Additional Distance Cost	Total Traffic Delay Cost
2	Partial	$22	-	$22
5	Full	$9,352	$3,191	$12,543
10	Full	$9,352	$3,191	$12,543
25	Full	$9,352	$3,191	$12,543
50	Full	$9,352	$3,191	$12,543
100	Full	$9,352	$3,191	$12,543

3.3.1.5 Weighting Adjustments for Return Interval

As shown in Table 3-6 above, the overtop tide elevation for each return interval is associated with an exceedance probability based on historic tide records. Using the 2 year return interval as an example, a tide of 1.51 meters is needed in order for waves from a 2 year event to overtop Highway 101. The table also shows that the probability of the tide being greater than 1.51 meters at any time is about 12.9 percent, which means that there is a 12.9 percent probability that Highway 101 would be overtopped during a 2 year event. Given a 12.9 percent probability that Highway 101 would be overtopped, there is a corresponding 87.1 percent probability that Highway 101 would not be overtopped during a 2 year event. As such, it is necessary to weight the economic damage figures by the probability that the tide will be of sufficient height to carry storm waves and associated debris over Highway 101, and cause damage to the three low-lying structures located at Cardiff. The probability adjusted damages are shown below in Table 4-5, and average annual damages for tide-related events through the 100 year event are $11,800.

Table 3-7
Tidal Probability Adjusted Damages

Return Interval	Traffic Delay Costs	Highway 101 Clean-up Costs	Restaurant Damage & Clean-up Cost	Total Wave Induced Costs	Tide Exceedence Probability	Probability Weighted Wave Induced Costs
2	$22	$1,160	$2,400	$3,562	0.129	$462
5	$12,543	$1,160	$2,400	$16,103	0.166	$2,673
10	$12,543	$1,160	$2,400	$16,103	0.198	$3,188
25	$12,543	$1,160	$721,810	$735,513	0.233	$171,375
50	$12,543	$1,160	$721,810	$735,513	0.264	$194,175
100	$12,543	$1,160	$721,810	$735,513	0.313	$230,216

3.3.2 Reaches 1 through 6, 8 and 9 - Shoreline Erosion Assumptions/Modeling

Characterization of a bluff failure requires 1) an understanding of the bluff toe notch erosion induced by wave attack at the base; and 2) some empirical correlation between the threshold value of the toe erosion and the upper bluff failure. The following sections summarize how these mechanisms affect each other and how they are modeled to predict future erosion and damages/costs. A detailed White Paper on the model development and application is included as **Appendix F**.

3.3.2.1 Bluff Retreat Modeling – Average Long Term Vs. Episodic

Past attempts to assess bluff retreat for use in estimating structural damages always resorted to the average erosion rate over a project design life, generated using existing deterministic synoptic summaries (USACOE-LAD, 1996). Though the annualized rate is a good indicator of the gradual, long-term retreat of the bluff top, it does not adequately represent the episodic nature of bluff failures, when almost instantaneously, several meters of bluff top can fail and fall to the beach below. An annualized retreat rate essentially accounts for the long-term average effect of various episodic events of bluff failure combined with the periods of little or no erosion activity. As a result, the annualized retreat rate, when averaged over a long period (e.g. 50 years), tends to yield a misleading picture of coastal cliff erosion and the resulting damage related to bluff-top development.

3.3.2.2 Monte Carlo Simulation

Therefore, this analysis employs the Monte Carlo Simulation technique to statistically characterize the unpredictable episodic bluff failures expected within the study area over a 50-year design life cycle. The first step in this type of statistical analysis is to determine what real world data is available in large enough quantities to create a statistically valid representation of the behavior of some component of the system (in other words, start with what you know). In this case, two types of data meeting this criterion have been identified. These are wave energy at the toe and historical bluff failures.

3.3.2.3 Wave Energy Database

The assumption was made that the storm energy spectrum of the last 22 years will continue into the next 50 years. Using deep water buoy historical wave records, transformation functions were developed for a set of 20 shallow water target points (a “line”) extending seaward from the shoreline at depths ranging from 1 to 20 meters (3 to 66 feet). The deduced nearshore wave characteristics were further transformed across the nearshore platform to the bluff base. Using the maximum energy period from the shallow water spectrum, breaker heights were also calculated using the empirical formula developed by Kaminsky and Kraus (1993). This allowed a linear transformation from available historical deep water wave energy data to wave energy at the bluff toe for 20 representative locations in the study area, over the entire 50 year study period. This 50 year time-line projection was then sampled at 3 hour intervals to include effects of changing tide and loaded into a database.

3.3.2.4 Site Specific Model Calibration – Toe Erosion as Function of Wave Energy

In addition to this data, site specific information was obtained which links specific storm events to measured notch erosion. Several sites in Solana Beach were selected for detailed measurement of notch and bluff erosion over a two year period. This period included several significant storm events and measurements were taken after each event. Knowing the wave energy at the toe during these events and the amount of toe erosion caused by that energy, a relationship could be derived mathematically to link the two. Research revealed that a semi-empirical numerical model was already developed by Dr. Tsuguo Sunamura, of the Institute of Geoscience, University of Tsukuba, Japan (Sunamura, 1982) to quantify short-term cliff erosion rate as a result of the wave force acting at the base and a function of rock resistance of the coastal cliff. Past field applications of this model indicated that only large waves during a storm event are responsible for inducing cliff erosion. This model has been adopted and calibrated using the actual data from Solana Beach, and provides a good estimate of notch erosion as a function of ; 1) wave energy at the toe and, 2) material properties.

With this model, toe erosion is generated from the wave energy database and simulated over a 50 year cycle. Some simplifying assumptions are necessary, however, to translate toe erosion to blufftop erosion.

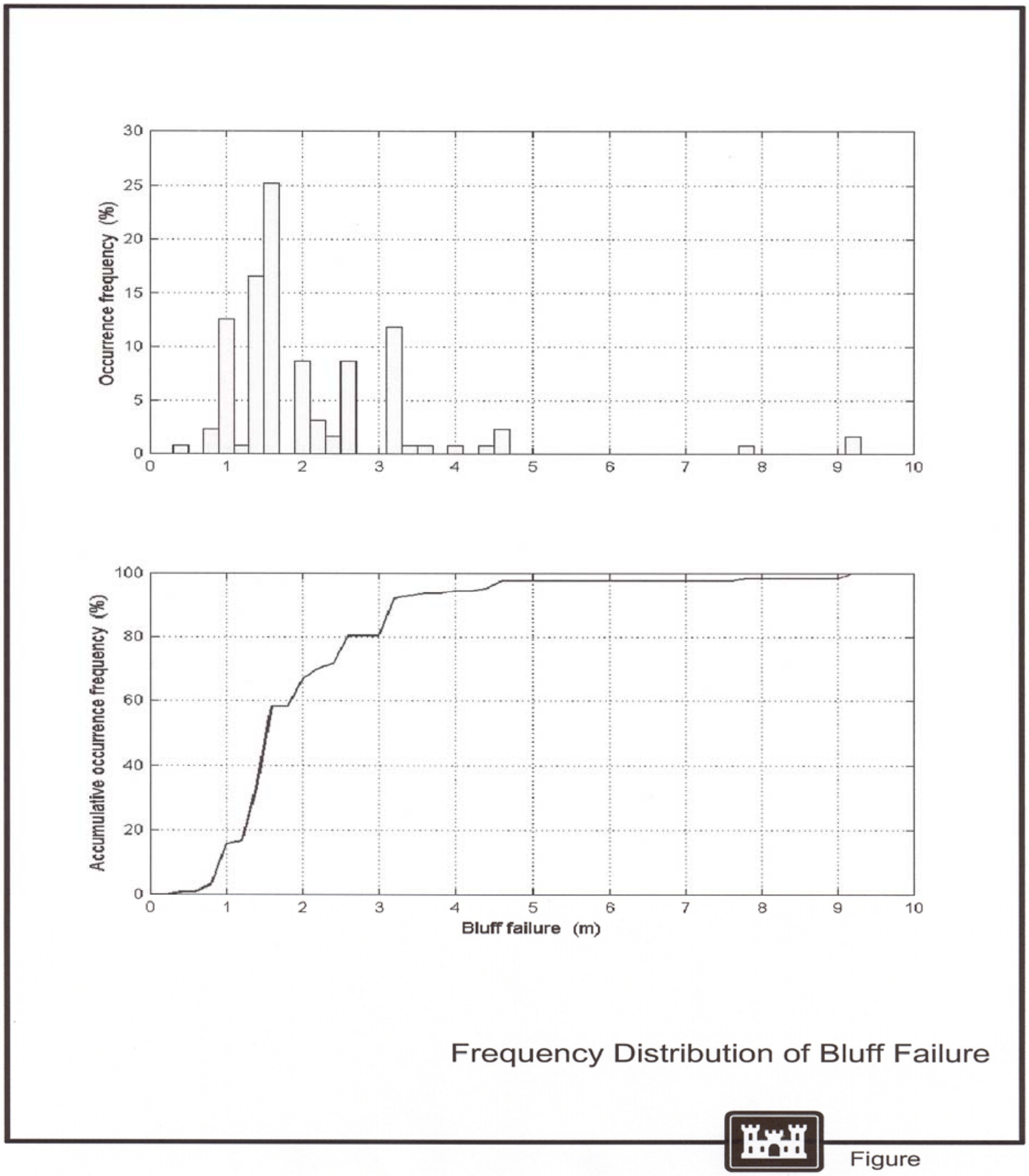
3.3.2.5 Toe Erosion Linked to Blufftop Erosion

Unfortunately, an empirical formula to predict the bluff top retreat as a function of notch erosion is not practical due to the extreme complexity of the internal structure of the bluffs and myriad other unknown factors that determine exactly how, when, and where a failure occurs. The uncertainty inherent in any formula which expresses blufftop retreat as a function of quantifiable parameters would render it meaningless. Therefore, a computer model was developed which combines the “Monte Carlo” Simulation technique with Sunamura’s toe erosion model to characterize the bluff retreat for a 50-year project design life. This method provides a more accurate and useful way of capturing and modeling the risk and uncertainty inherent in natural, non-linear systems.

3.3.2.6 Bluff Failure Database

A statistically valid (representative) database of historical bluff failures was needed to provide the missing link in the model. Bluff failure records, including photos, newspaper articles, and city staff logs were examined for the entire study area since 1990 and over 193 significant events were recorded. Of these, 127 had enough detailed information to qualify for inclusion in our database. Although the maximum bluff retreat was almost 9 meters in depth, most of the failures had a depth of 0.8 to 3.2 meters. The Coastal Engineering Appendix contains a complete listing of bluff failures used in the database. An analysis of notch depths in the study area indicates that a notch depth of 8 feet has a 90% likelihood of causing bluff collapse, therefore, it was assumed that when a notch reached 8 feet, a collapse was triggered. The bluff failure database provides the amount of land loss produced by the collapse (by random selection), so that the model accurately simulates the real-world size distribution of significant bluff failures. A histogram of this distribution is presented in **Figure 3-6**, below.

FIGURE 3-6 BLUFF FAILURE SIZE DISTRIBUTION



3.3.2.7 Model Structure – Bluff Erosion

As discussed above, the core of the model actually consists of two separate Monte Carlo type simulations (random sampling based on a statistical distribution). The two statistical databases of actual historical events are; 1) wave energy at the bluff toe, and 2) bluff failure sizes (amount of blufftop terrace lost). In brief, the model simulates a 50 year cycle at three hour increments and predicts bluff-top setback for a given parcel at any given year. The model is run one thousand times to reach convergence of the mean and standard deviation. Economists then use this data to compute the distribution (spatially and temporally) of potential costs, damages and property loss during a 50 year cycle.

3.3.2.8 Critical Model Input Parameters – Initial Conditions

The two spatial dimensions that must be defined as initial conditions were estimated from field measurements, photographs, and detailed topographic data, and they are:

1) Setback - The initial (existing) distance from each of these structures to the edge of the bluff , and

2) Notch Depth - The approximate depth of any existing notch at the bluff base.

277 parcels in the study area sit directly atop the cliffs overlooking the Pacific Ocean and contain residential or other structures with assessed values greater than zero. These parcels were segregated into nine geographic reaches, and existing toe conditions were estimated for each parcel. Starting notch depths were classified within each reach by: 0-2 feet of bluff toe notch; 2-4 feet of bluff toe notch; 4-6 feet of bluff toe notch; and 6-8 feet of bluff toe notch. Reach 7 was not included because it does not include threatened structures atop eroding bluffs.

Table 3-8 shows the distribution of notch depth by no. of structures, within each reach. Reach 7 is not included because it is a low lying sand spit. **Figure 3-6** shows a typical notch depth of 4 to 6 feet in Reach 3.

Table 3-8. Bluff Toe Notch Depth Assignment to Study Area Parcels

Reach	Notch Depth 0 - 2 Feet	Notch Depth 2 - 4 Feet	Notch Depth 4 - 6 Feet	Notch Depth 6 - 8 Feet
1	98			
2	27			
3	27		9	24
4	24		30	
5	5	17	19	11
6	30			
8	20	5	13	32
9	9	1	2	3

FIGURE 3-7 STUDY AREA STRUCTURES IN REACH 3 WITH 4 TO 6 FOOT DEPTH BLUFF TOE NOTCH

3.3.2.9 Emergency Seawall Costs

Early in the analysis it was recognized that property owners would take some action to prevent the loss of their homes. In the FWOP scenario, it was assumed that property owners would install a seawall at their own expense. This cost is estimated for the purpose of calculating costs avoided when analyzing Federal Project alternatives.

As discussed in section 3.2.2, a total cost of $2,975 per linear foot of seawall plus $120,000 for associated costs per seawall was assumed based on actual recent costs in the study area.

In the FWOP scenario, damages are calculated in terms of armoring costs and any loss of blufftop frontage land. The sum of the present values of damages over the 50 year analysis period is annualized (using a discount rate of 5.375%), and the result is the expected annual damages for the study area.

The @Risk simulation software package was used to address minor uncertainties in the measuring and estimating process, and as a tool to iterate the analysis through 1000 sets of 50 year data. One thousand different model runs were provided by the engineering analysis for annual land erosion in each reach / toe-depth combination. Each calculation of the model equals a single iteration, and this step was performed 1,000 times (using the Uniform Integer distribution function in @Risk). Each model run returns damages from one 50 year simulation period (i.e., a model iteration consists of a full run through the 50 year period). The model is complete after it has cycled through all 1,000 iterations of 50 year periods. After the model has completed the 1,000th 50 year period, expected values and other associated statistics are computed. A more detailed explanation of the model may be found in the **Economics Appendix**, and a complete description may be found in the White Paper, attached as **Appendix F.**

3.3.2.10 Model Structure – Damage Calculations

The damage calculation model consists of four linked Excel spreadsheets, including Erosion Rates, Land Erosions, Parcel Erosions and Damage Calculations.

The first spreadsheet, “Erosion Rates” is the master land erosion database described above. This file shows the annual loss estimate for each reach / toe-depth combination, over 50 years and 1,000 iterations.

The second spreadsheet, “Land Erosions” applies the erosion estimates in “Erosion Rates” to the specific parcels in the parcel database. For each parcel, the reach / toe-depth combination is recorded. An Excel lookup function is then used to retrieve (from the “Erosion Rates” file) the annual land erosion for that reach / toe-depth combination *for one iteration of the model*. The land erosion estimates are updated during each of 1,000 iterations.

The third spreadsheet, “Parcel Erosions” calculates the remaining distance between the existing structure (if any) and the edge of the bluff, after annual land erosion. The sum of the land erosions calculated in “Land Erosions” are subtracted from the initial distance to the bluff, and the result is the remaining distance to the bluff for a given year. Again, these calculations are performed 1,000 times when the model is run.

The final spreadsheet, “Damage Calculations” uses the land and parcel erosions calculated above to determine when to calculate damages (land loss and seawall construction costs) for each parcel. The Economics Appendix contains detailed information on assumptions and methodologies used in the model.

3.3.3 Shoreline and Bluff Erosion Damages - Model Results

The average annual damage (loss of land and stairs plus protection costs) from the base year 2009 to 2058 for the entire study area (Reaches 1-9) equals $1,776,747. The standard deviation of the distribution equals $150,689. The median, minimum, and maximum observed values equal $1,777,459, $1,195,240, and $2,249,028, respectively. The distribution of results follows a fairly normal pattern; with no visible skewness toward either higher or lower numbers. Protection and loss of stairs costs constitute $1,247,971 of the total. The average annual total damage in the first year (2009) of the analysis is estimated at $146,048; with a range from $0 to $763,641.

Average annual damage estimates by reach for the without project—armoring model are provided in Table 3-6. These results assume a base year of 2009 and the current discount rate of 5.375%.

Table 3-9
Annualized Emergency Protection Costs/Land Loss Damages Incurred by Reach – Armoring Scenario

Reach	Total Damage	Armoring Cost and Stair Damage	Loss of Land
1	$0	$0	$0
2	$19,629	$5,362	$14,267
3	$164,817	$130,612	$34,205
4	$325,406	$215,905	$109,501
5	$467,081	$318,725	$148,356
6	$327	$35	$292
7	$0	$0	$0
8	$375,792	$306,815	$68,977

9	$423,695	$270,517	$153,178
Total	**$1,776,747**	**$1,247,971**	**$528,776**

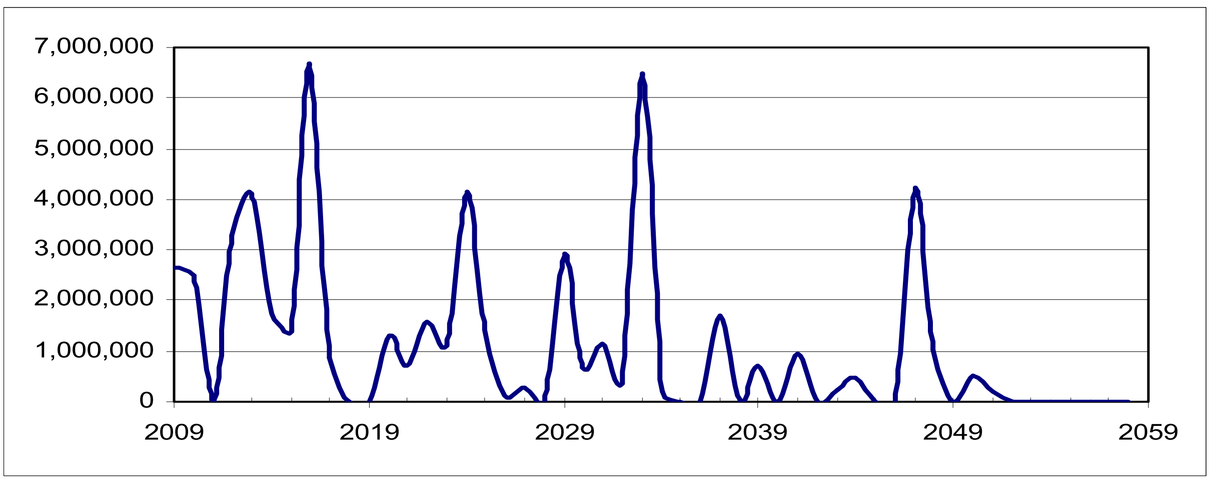
Total Annual Existing Conditions Storm Damages

The average annual storm damage related to bluff-top properties, clean-up costs and damage to low-lying coastal properties amounts to approximately $1,788,548 under the Armoring Scenario. This value is comprised of:

- Average annual damage of $1,776,748 for future bluff-top land and structures losses; and
- $11,800 average annual damages in terms of clean-up costs for Highway 101, travel delay costs, and damages to the three restaurants located in Cardiff.

Figure 3-8 below, shows the temporal distribution of the combined total damages/costs over the project life.

FIGURE 3-9 DAMAGES / EMERG. PROTECTION COSTS OVER TIME



3.3.7 Sensitivity Analysis – No New Seawalls.

In addition to the FWOP scenario described above, a sensitivity analysis was performed to estimate blufftop structural damages assuming no new seawalls were built over the study period. This analysis was performed for several reasons, the most important of which is to justify the costs incurred by homeowners to protect their investments. Table 3-xx displays the estimate of annual property damages by reach assuming no new seawalls are built over the planning horizon.

Table 3-10 Average Annual Bluff-Top Property Damages by Reach – No New Seawalls Scenario

Reach	Structure Damages	Land Damages
1	$0	$0
2	$2,500	$20,100
3	$270,700	$647,800
4	$252,200	$544,000
5	$160,800	$385,100
6	$0	$0
8	$461,300	$678,400
9	$1,142,400	$1,061,100
Total	$2,289,900	$3,336,500

The analysis indicates that the average annual structural damages in the absence of any further protection would be $5,626,400; approximately twice the cost of seawalls. These results validate the assumption that homeowners would likely build seawalls to protect their properties. The Economics Appendix includes a detailed discussion of this analysis.

3.3.4 Recreation

Under Future Without Project Conditions, recreational opportunities will be severely degraded by the loss of beach sand. Although the SANDAG Regional Beach Sand Project provided additional beach width in some reaches upon it's completion in 2002, the effects of this one time replenishment are fading, and beach widths in the study area are expected to return to pre-SANDAG conditions (denuded) before 2008, and thus before the project Base Year. The analysis below discusses the future recreation market in the study area and provides a valuation of the projected recreational activity under these conditions.

3.3.4.1 Recreation Market Area

The recreation market area for study area beaches is largely dependent upon the travel distance (closely associated with the travel cost) and the availability of alternative locations that offer similar recreational opportunities. Two recent surveys of beach users at City of Encinitas and City of Solana Beach (King 2002) indicate users are willing to travel some distance to study area beaches and not all beach users are local residents. For beaches at the City of Solana Beach, 34% of respondents traveled more than 20 miles one-way and 28% traveled more than 60 miles. Twenty-eight percent of respondents were on an overnight trip (though not necessarily for the single purpose of beach use). For beaches at the City of Encinitas, 35% of respondents traveled more than 20 miles one-way and 26% traveled more than 60 miles. Twenty-four percent of respondents were on an overnight trip, and the same caveat about primary trip purpose applies.

For the purpose of this analysis, the recreation market area for study area beaches is solely contained within San Diego County. The market area contains primary and secondary sub-areas. The primary market area consists of locations that have direct access to study area beaches or the study area is clearly the closest coastal area. The secondary market areas are locations that are removed from the coast, but are closer to the study area than to beaches to the south or north. The populations of secondary market areas are discounted by 50% to account for the increased distance and the availability of other beach use options. Areas with direct access to non-study area beaches are not included in the market area.

Primary market locations include the cities of Vista, Escondido, Encinitas, Solana Beach, and San Marcos. Secondary market locations include the cities of San Diego, Poway, San Tee, and the unincorporated areas of San Diego County.

Areas not included in the study area recreation market area are all areas outside of San Diego County, areas to the north of the City of San Diego including Del Mar, Oceanside and Carlsbad, and areas to the south of the City of San Diego including El Cajon, La Mesa, Lemon Grove, National City, Chula Vista, Coronado, and Imperial Beach.

Table 3-11 shows recreation market area population projections (SANDAG 2003), including the 50% reduction of secondary market area populations, and growth rates for 2000 – 2030. As indicated by the data, the market area population is expected to grow at a slow rate through 2020 and then decline between 2020 and 2030. The overall annual growth rate from 2000 to 2030 is projected to be 1.09%.

Table 3-11. Study Area Recreation Market Population Projections

	2000	2010	2020	2030
Population	1,233,055	1,401,476	1,563,144	1,708,718
Growth rate		1.29%	1.10%	0.89%

3.3.4.2 Beach Use Valuation

Beach recreation provides value to users that cannot be estimated by market prices. Entrance fees and parking fees are not useful indicators of the value of beach use because many users do not pay fees and the fees are not set by market forces. Non-market valuation techniques are typically used to estimate beach recreation value. One common non-market valuation method is the Unit-Day value (UDV) method as described in EGM 05-05, Unit Day Values for Recreation Fiscal year 2005. Another value estimation method is known as the Travel Cost Method (TCM), which uses the costs incurred by individuals traveling to a recreational site as a surrogate for price, and ultimately makes it possible to derive a demand curve and estimate total user value associated with a particular recreation site. The TCM requires site-specific visitor surveys, and, as a result, the informational requirements for the TCM are much higher than for the UDV method. Prior detailed studies of recreation along California's beaches have shown that the UDV method consistently results in a lower value estimate than the TCM. In 2001, Dr. Philip King of San Francisco State University estimated the summer day use value for Encinitas and Solana Beaches at $22.17 and $17.35 respectively. However, these studies used relatively small sample size to estimate the day use value for the summer season.

The values per user day for the UDV method, which are updated each year by USACE Planning Community of Practice, range from $3.09 to $9.28. In this way, the values resulting from the UDV can be considered conservatively low. Importantly for this study, in accordance with USACE ER-1005-2-100, the potential benefits from recreation are capped at the value of storm damage reduction benefits. That is, recreational value cannot comprise more than fifty percent of the total benefits. For this study, even using the ostensibly lower UDV method, the recreational benefits exceed the storm damage benefits, and, as such, the choice of recreation value estimation method is not expected to impact the results of the study. The current, 2005, UDV point value estimate for beach recreation in the study area is 57[1]. Under existing future conditions, the UDV for beach recreation is estimated to decline to 34 by the study's base year of 2009. This base year point score is based on the following UDV criteria: a score of 3 for recreation experience; 3 for availability of opportunity; 4 for facility carrying capacity; 18 for accessibility; and 6 for environmental amenities. A score of 34 for general recreation indicates a unit day value of $5.10 per trip.

It is expected that the UDV will be held constant at $5.10 (which corresponds to a score of 34) over the entire period of analysis (2009 through 2058). This is because it is expected that no new beach

1 This UDV point measurement comes after a recent sand replenishment.

replenishment projects will occur at the study area under the without project condition. The winter beach profile is expected to have a width of zero feet over the period of analysis.

Table 3-12, below, shows projected study area beach use and recreation value for 2000 – 2030. Participation projections are based upon beach attendance data and the projected growth rate for the study area recreation market area. Beach use values are based upon the unit day value method discussed above.

Table 3-12 Projected Study Area Beach Recreation Participation and Value

	2000	2010	2020	2030
Participation	4,972,233	5,651,381	6,303,299	6,890,321
Total Value	$34,706,186	$28,844,649	$32,172,038	$35,168,198

Beach use valuation scores were developed through informal discussions with local beach users, discussions of beach characteristics and beach user characteristics with local agency officials, and knowledge of the local area. Table 3-13 (see below) was generated, and also includes updated Unit Day Values contained in EGM 05-05.

Table 3-13
Unit Day Value Scores: Existing Conditions

Category	2003	2009	2058	Maximum
Recreation Experience	10	3	3	30
Availability of Opportunity	3	3	3	18
Carrying Capacity	11	4	4	14
Accessibility	18	18	18	18
Environmental	15	6	6	20
Total Score	57	34	34	100
Unit Day Value	$6.98	$5.10	$5.10	$9.28

The net present value (NPV) of recreation for the overall study area under existing conditions during the 2009 to 2058 analysis period, assuming no further growth beyond 2030, is $556,568,000 ($32,270,000 on an equivalent annual basis).

3.3.5 Public Safety

Public safety will continue to be an issue due to narrow beaches and sudden bluff failures. The potential for further death or injury to beach users will only increase as the beach becomes narrower and notches continue to erode causing further bluff failures. In addition, there will be more potential for death or injury to blufftop residents as the setback distances decrease and structural damages increase over time.

3.4 Shoreline Environmental Resource Impacts Under Future Without Project Conditions (No Action)

Under Future Without Project Conditions (No Action), shoreline environmental conditions are not expected to change significantly. There may be some additional loss of sandy beach habitat as the shoreline erodes, and some low value coastal scrub may be lost as protective structures are placed on vegetated bluff faces.

3.4.1 No Action – Marine Habitats

Plankton

Under the No Action Alternative, there would be no potential for short-term project-related turbidity impacts on the plankton community.

Vegetation

Under the No Action Alternative, there would be no potential for project-related construction disturbance and/or sedimentation effects on vegetation species (surfgrass, feather boa kelp, sea palms, giant kelp).

Fish and Wildlife

Under the No Action Alterntive, there would be no potential for project-related construction sedimentation and/or disturbance effects on marine invertebrates, including sea fans, which are an indicator of sensitive reef habitat. Similarly, there would be no potential for impacts to fish under the No Action Alternative.

Habitat for grunion is limited under the baseline condition, which is characterized by narrow and sand depleted beaches. Continued beach erosion under the No Action Alternative may result in additional loss of sand depth and width, which could further decrease potential habitat for grunion under the 50-year without-project condition. Under the No Action Alternative, there would be no potential for improved habitat for grunion as a result of beach enhancement.

Threatened and Endangered Species

The No Action Alternative would have no impact on threatened or endangered marine species. None occur within the shoreline, nearshore, or offshore habitats within the study area.

Other Sensitive Species

Under the No Action Alternative, there would be no impacts to marine mammals, sea lions and seals would be expected to occasionally haul out on beaches within the study area. Dolphin and gray whales also would continue their use of offshore waters for foraging and/or migration.

3.4.2 No Action – Terrestrial Shoreline Habitats

Vegetation

Under the No Action Alternative, vegetation along the coastal bluffs and terrestrial shoreline would be expected to remain similar to the baseline condition, which is dominated by non-native vegetation. As portions of coastal bluffs continue to erode or be armored over the next 50 years, some vegetation growing on or at the base of the bluffs also will be lost. This disturbance would favor persistence by opportunistic non-native species.

Wildlife

Under the No Action Alternative, there would be little potential for project-related construction disturbance to birds and other wildlife. Terrestrial wildlife along the shoreline will continue to consist primarily of urban-adapted species such as American crows, house finch, and rock doves, and black phoebe, which is associatd with cliffs and/or man-made vertical structures. The terrestrial habitat along the bluffs has little value for wildlife under baseline conditions because of the dominance by non-native vegetation and its general isolation from native habitats. As portions of coastal bluffs are armored over the next 50 years, there would be disturbance and some loss of habitat for wildlife. Therefore, the value of the coastal bluffs for wildlife may decline slightly.

The sand beaches in the project area provide some foraging area for shorebirds and resting areas for seabirds and shorebirds under appropriate tidal conditions. Continued beach erosion under the No

Action Alternative may result in loss of sand depth and width. Thus, there may be a decrease in quality and size of habitat for shorebirds and seabirds under the 50-year without-project condition. There would be no potential for improved foraging and/or resting opportunities for shorebirds and seabirds as a result of beach enhancement.

Threatened and Endangered Species

Under the No Action Alternative, there would be no potential to impact threatened and endangered plants. Over the next 50 years, habitat for federally-listed plants will be poor quality along the shoreline and coastal bluffs, which under baseline conditions provide only a low potential for occurrence of coastal dunes milk-vetch, Del Mar manzanita, Encinitas baccharis, Orcutt's spineflower, San Diego ambrosia, and short-leaved dudleya. Similarly, there would be no potential to impact federal- and state-listed wildlife. No substantial change would be expected over the next 50 years in foraging habitat for California brown pelican and California least tern, which under baseline conditions forage offshore the study area. Similarly, no change would be expected in foraging and/or potential nesting habitat along the coastal bluffs for peregrine falcons, which under baseline conditions have been reported from the study area. No change would be expected with the future 50-year without project condition in the potential for occurrence of Pacific pocket mouse, which is considered moderate under baseline conditions.
Western snowy plover forage on beaches near Batiquitos, San Elijo, and San Dieguito Lagoons under baseline conditions; thus, there is the potential for their occurrence within the shoreline study area in the 50-year future without project condition. The quality and size of intertidal habitat within the study area may decrease over the next 50 years associated with continued beach erosion. Under the No Action Alternative, there would be no potential for improved habitat for western snowy plover as a result of beach enhancement.

3.4.3 No Action - Offshore Cultural Resources

Under the Future Without Project Conditions (FWP), no change is anticipated in the status of any offshore cultural resources.

3.4.4 No Action – Onshore Cultural Resources

Under the No Action Plan, no impacts are expected to any shoreline cultural resources.

Chapter 4. Plan Formulation

Planning Process, Planning Opportunities, and Alternative Formulation.

Plan Formulation can be broken down into a six step process:

1. Identify Problems and Needs

2. Inventory and Forecast Conditions

3. Formulate Alternative Plans

4. Evaluate Alternative Plans

5. Compare Alternative Plans

6. Select a Recommended Plan

This process is a structured approach to problem solving which provides a rational framework for sound decision making. The six-step process is used for all planning studies conducted by the Corps of Engineers.

The sections below first provide an introduction to plan formulation objectives, constraints, and preliminary alternatives and measures considered. These measures are then screened and developed into project alternatives for full analysis. A tentatively recommended plan is finally identified which best meets the stated objectives and constraints.

4.1 National Objective

Federal and Federally-assisted water and related planning activities attempt to achieve increases in National Economic Development (NED), while preserving environmental resources consistent with established laws and policies. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. The NED objective is differentiated from Regional Economic Development (RED) benefits, which only apply to a given region, often at the expense of another region in the U.S. NED benefits accrue nationally for a net gain in Gross Domestic Product. They represent return on the investment of Federal funds, and are a useful tool in comparing the efficiency and effectiveness of alternative projects on a nationwide basis. Plans are formulated to take advantage of opportunities in ways that contribute to the NED objective. In accordance with ER 1105-2-100, it is Corps policy to provide Federal assistance in the prevention or reduction of damages caused by wind and tidal generated waves and currents along the Nation's shoreline.

The standard period of analysis is based on a 50 year functional project life. Damages (which may be financial costs or actual structural/infrastructure damages) and lost opportunities (recreational, etc.) are projected for the future without project and for the future with an array of different alternatives. The benefits of each alternative are expressed in dollar amounts of damages prevented and opportunities preserved or created.

4.2 Public Opinion

Numerous public workshops were held both during the reconnaissance and feasibility phases of the study. Below is a summary of public hearings at which the study objectives and results to date were shared and the public had an opportunity to get comments on the record and ask the study team questions.

- Reconnaissance Workshop, 26 Jun, 1995
- F2 Public Workshop, Encinitas City Hall, Oct. 23, 2001
- City Council Meeting, Solana Beach, July 24 2003
- City Council Meeting, Solana Beach, Oct . 11 2003
- Public Workshop, Encinitas City Hall, July 22, 2004

There is a great deal of public interest in shoreline issues in the study area. Public meetings addressing these issues are always well attended. Although nearly everyone supports beach replenishment, opinion seems to be generally polarized by the issue of coastal structures, whether toe protection or offshore structures. Local citizens have formed committees to advocate their views on this issue before policy makers and public officials. Below is a summary of the main points of the debate.

Those who oppose “hard” coastal structures feel that in general, they;

1. are dangerous and ineffective
2. are ugly and ruin the view of the coastline
3. accelerate beach erosion
4. degrade surfing conditions
5. encroach on public beach and swimming areas

Those who support coastal structures feel that, if properly designed, they:

1. safely and effectively reduce/prevent property damage
2. can be built small and aesthetically pleasing
3. do not accelerate beach erosion
4. do not necessrily degrade surfing conditions
5. do not encroach on public beach

More workshops are now being scheduled to present and discuss the alternative plans and solicit further input. A complete digest of the public's comments to date can be found in **Appendix A**, "Public Involvement". Public input will be carefully weighed in the Final recommendations.

4.3 Planning Objectives and Criteria

4.3.1 Objectives

Based on the analysis of the identified problems and opportunities and the existing conditions of the study area, planning objectives were identified to direct formulation and evaluation of alternative plans.

These objectives are:

1. To protect public property and reduce storm related damages to residential, commercial, and public facilities along the bluffs and shoreline.

2. To protect Hwy 101 and structures along Cardiff (Reach 7) from storm damage and closure.

3. To address safety concerns associated with bluff failures.

4. To enhance recreational opportunities associated with the beach.

5. To preserve or improve environmental resources along the shoreline (including San Elijo Lagoon).

Alternatives are formulated to maximize storm damage reduction and minimize cost. To be recommended, their benefits must exceed their costs by NED criteria (see Economics Appendix). Improvements to safety and recreational opportunities resulting from any alternative are considered incidental to the main objective of reducing storm damages. All alternatives must undergo both National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) review processes. The purpose of the Environmental Impact Statement (EIS) is to identify and present information about any potentially significant environmental effects of the alternatives and the recommended plan.

4.3.2 Criteria

Plans are then compared using four formulation criteria suggested by the U.S. Water Resources Council. These criteria are;

Completeness - Completeness is a determination of whether or not the plan includes all elements necessary to achieve the objectives of the plan. It is an indication of the degree that the outputs of the plan are dependent upon the action of others.

Effectiveness – All of the plans in the final array provide some contribution to the planning objectives. Effectiveness is defined as a measure of the extent to which a plan achieves its objectives.

Efficiency – All of the plans in the final array provide net benefits. Efficiency is a measure of the cost effectiveness of the plan expressed in net benefits.

Acceptability – All of the plans in the final array must be in accordance with Federal law and policy. The comparison of acceptability is defined as acceptance of the plan to the local sponsor and the concerned public.

4.4 Planning Constraints

Engineering and Physical Constraints. The recommended plan presented should be complete and sound, and in sufficient detail to allow development of engineering plans and specifications.

Economic Constraints. Any potential project that is in the Federal interest must display feasibility by satisfying benefit-cost (B/C) criteria. Generally, this ratio must be greater than one to allow Federal participation in continued study and any project proposal. For Environmental Restoration projects, an incremental analysis must be performed to compare cost effectiveness of the alternatives.

Financial Constraints. The sponsoring agency is required to show their ability and willingness to fund their share of any recommended project as required by the Principals and Guidelines.

Environmental Resource and Agency Constraints. Applicable environmental requirements must be met for a feasibility level study. Environmental acceptability must be ascertained; adverse impacts should be avoided if possible or minimized, if avoidance is not possible. An Environmental Impact Statement (EIS) is included with this Report.

Local Constraints (Public Acceptability). The alternative options and plans should be acceptable to the local residents, agencies, organization, and the non-Federal sponsor(s), as well as the interested State and Federal agencies. The local sponsor has indicated that they are severely constrained by public opinion and cannot support any recommendation that meets with severe public opposition. Unacceptable plans include any visible offshore structure and any structure that significantly impedes beach access, such as rock revetments.

4.5 Preliminary Formulation – Conceptual Alternative Measures Considered

Methodology

Plan formulation begins with the largest possible selection of alternatives, and screens them down through finer and finer analysis and comparison. A preliminary screening of the plans narrows the field by eliminating those plans that prove unacceptable or infeasible at a closer look. Measures passing this screening are developed and screened further until a final array of measures is selected. Any implementable combination of these measures may be considered a separate alternative. Each final alternative receives full Feasibility level development, analysis, and comparison.

Available Measures

Available methods to eliminate or reduce coastal storm damages and shoreline erosion include seawalls and revetments, beach nourishment-with or without groins, and offshore breakwaters. Seawalls and revetments are placed parallel to the shoreline as a last line of defense to protect adjacent land areas from direct wave attack, flooding and erosion. As such, they often provide the most reliable form of shoreline protection, however, they do nothing to increase beach width, and can impede public access to the beach. Beach Nourishment is highly effective at protecting the coastline as long as the beach is maintained. Groins are cross-shore retention structures that act as a barrier to alongshore sediment transport The amount of sand trapped by the structure depends on the permeability, height, and length of the structure.
Offshore breakwaters are effective at retaining sand, but are expensive and require a healthy source of littoral sand to perform their sand trapping function. Groins are cross-shore retention structures that act as a barrier to alongshore sediment transport

In general, for a given alternative, the design and cost (per linear unit of shoreline) should not vary significantly from reach to reach. In addition, the effectiveness of each measure at protecting the bluff toe should not vary much from reach to reach, when properly designed. However, seawall costs in Solana Beach (Reaches 8 and 9) will be higher per unit than seawall costs in the other reaches. This is because in Solana Beach the mid bluff contains a larger lens of unconsolidated sand, requiring extra stabilization structure. (see **Geotechnical Appendix**).

The following sections briefly discuss each of the measures mentioned above, and indicate whether the measure was screened out or carried forward for further analysis in subsequent sections of the report.

4.5.1 Future Without Project (Private Piecemeal Protection)

The Future Without Project (FWOP) alternative is necessary for comparing the costs and benefits of different alternatives, and is described previously in this report and in the Economics appendix. It serves as the baseline by which other alternatives may be judged and compared to each other. This alternative is defined by no Federal project occurring. The assumption is made that existing seawalls will continue to be maintained, and private homeowners will continue to be granted emergency permits to build new ones. Reach 7 will continue to suffer flooding damages and Hwy 101 closures. Under this scenario, most of the shoreline will be armored within 20 or 30 years, but in an inefficient, uncoordinated process and only after significant loss of land. Assumptions, costs and impacts of this alternative have been presented previously in this document and are detailed in the Economics Appendix. The Future Without Project condition is always carried into the final analysis of alternatives as a baseline for comparison. Damages and costs incurred under FWOP conditions were discussed in detail in the previous section.

4.5.2 Future With Project -Non Structural Measures

Alternative plans can be broken into structural and non-structural categories. Non-structural alternatives include revising management or maintenance practices, acquiring real estate, or replenishing the beach (although this is sometimes called a “soft structure”). Anything that achieves the project objectives without a hard structure is considered a non-structural alternative. For this study, non-structural measures identified include Beach Replenishment, Managed Retreat, and Best Management Practices. Nearshore sand berms are discussed in **Section 4.5.3.1.**

4.5.2.1 Beach Replenishment

Beach replenishment involves placement of compatible sand from a borrow area outside of the littoral zone to effectively widen the beach. The increased sand buffer distance accommodates short-term sediment losses so that storm waves and runup dissipate over the wider fill profile. Long-term losses and erosion are addressed through periodic renourishment of the fill.

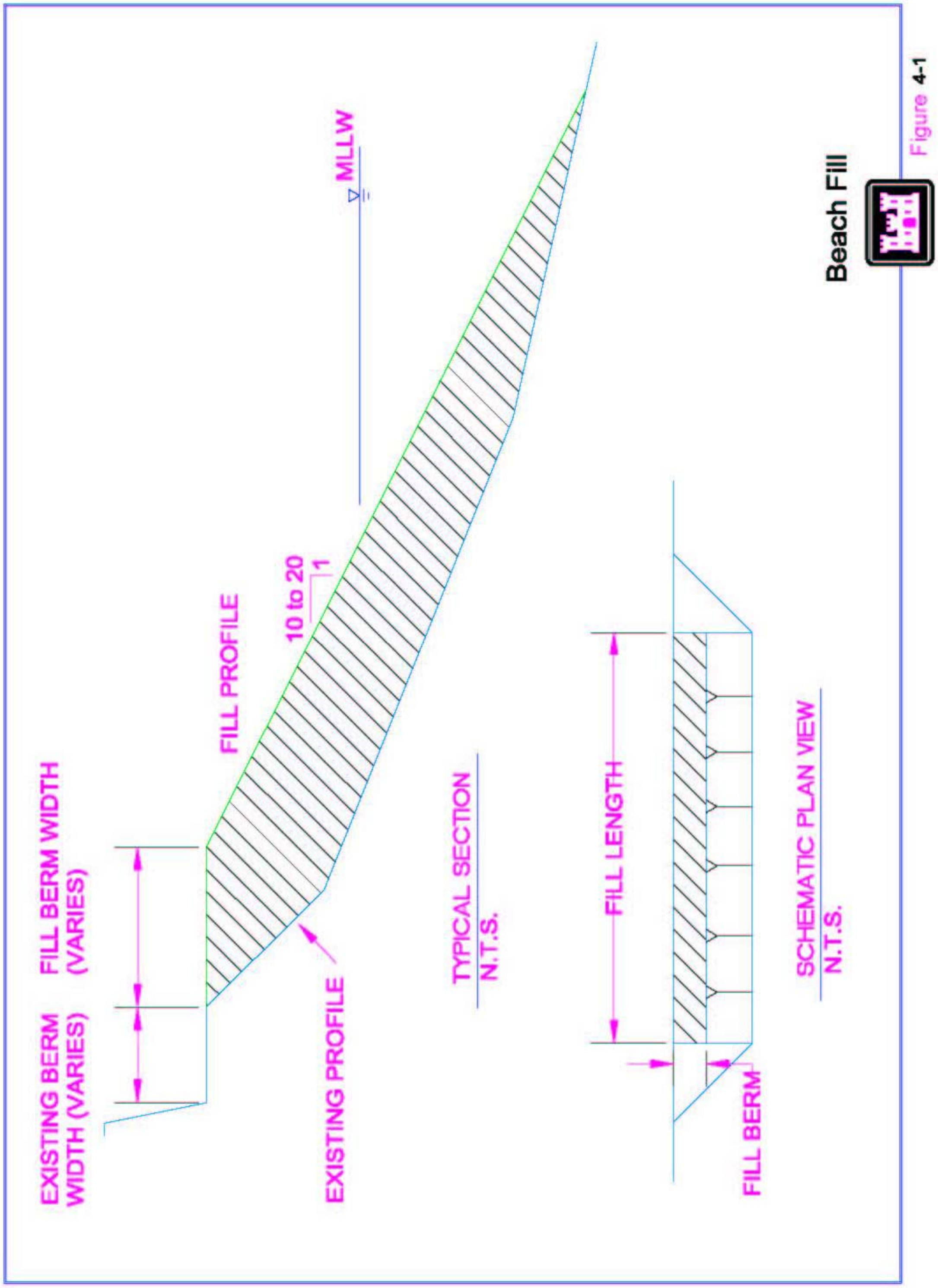
Design Methodology –

Historical observations within Southern California indicate that a minimum beach width of approximately 60 meters is required to prevent a subject beach being completely eroded away during a severe winter season (USACE-LAD, 2003." Coastal of California Storm and Tidal Waves Study South Coast Region, Orange County", Final Report, 2003). Oceanographic and bathymetric conditions in the study area are very similar to Orange County. Based on this consideration, a minimum berm width of 60 meters was proposed for both shoreline segments. The design berm height and front-face slope follow the beach-fill dimensions that were employed in the SANDAG project (Noble Consultants, 2001).

The beachfill design parameters were determined by considering various combinations of beach-fill widths and different replenishment cycles. Each option has one combination of an initial beach width and a repetitive duration for the subsequent renourishment cycles. The optimal option is the one that yields the maximum net benefit. The Corps GENEralized Model for Simulating Shoreline Change (GENESIS) was used to predict the shoreline morphology over multiple years as waves redistribute sand after it is placed mechanically on the beach. The optimization consisted of finding the beach width and renourishment period for both segments that maximized the net benefits while avoiding known sensitive nearshore habitat.

Beach Nourishment is carried forward into the NED analysis. The concept design is schematically illustrated in **Figure 4-1.**

FIGURE 4-1 TYPICAL BEACH NOURISHMENT DESIGN

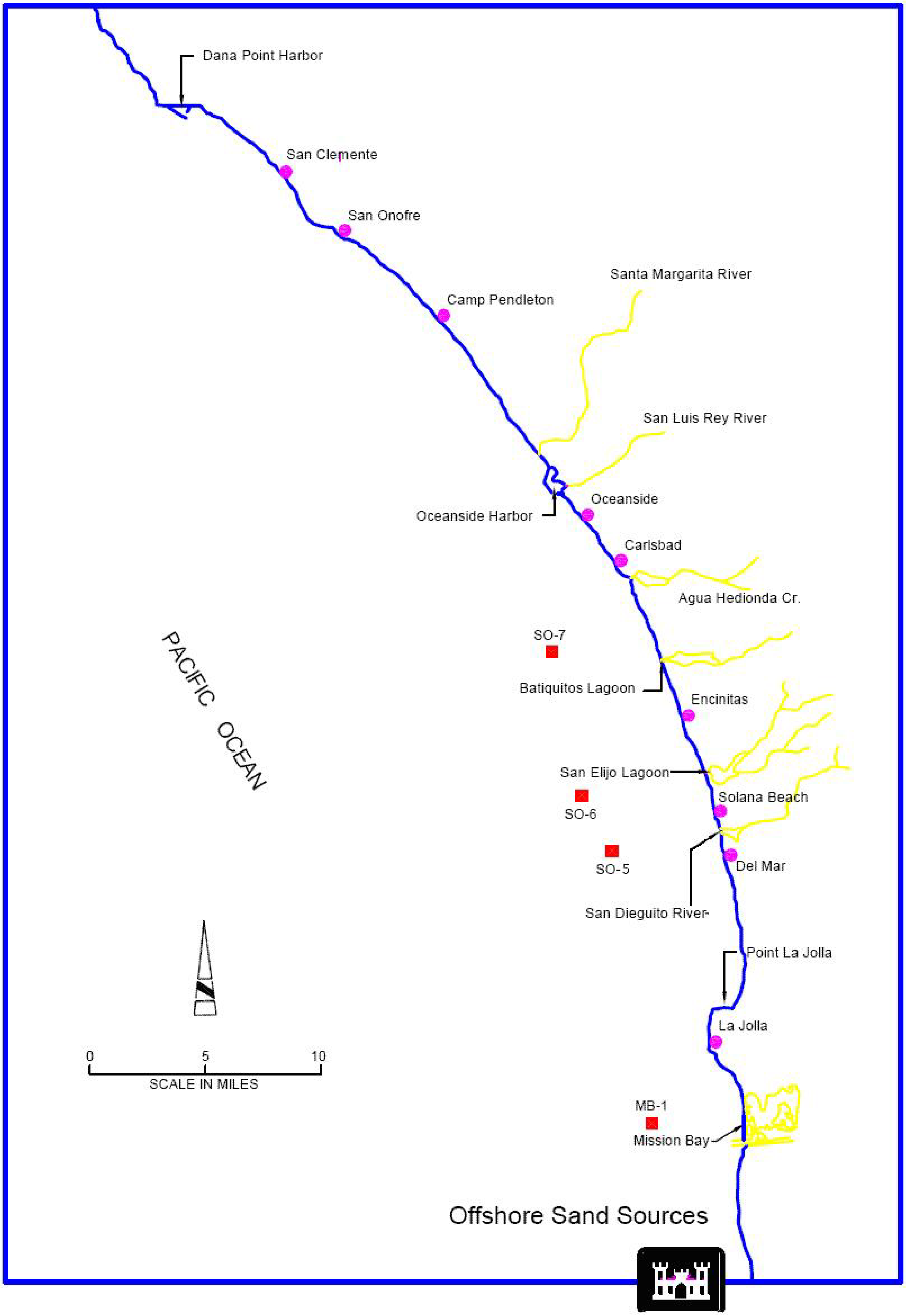


Beach replenishment can occur using offshore or onshore borrow sites. In general, in the study area, offshore sources have historically been used for several reasons, discussed below.

Offshore Borrow Sites

Prior offshore studies of the area conducted by the Corps of Engineers and other government and private agencies (SANDAG) have identified at least three potential sources of sand suitable for an offshore borrow site. The approximate location of these sites is given in **Figure 4-2**, below. The Potential Offshore Borrow Sites in the study area investigated for the SANDAG Sand Replenishment project are designated SO-5, SO-6, and SO-7. The SANDAG Project also investigated and used another site designated MB-1, located offshore of Mission Beach, several miles south of the study area. There is potential for large volumes available, but further investigations may be required during the PED phase to precisely quantify the amount of material at each borrow site suitable for beach replenishment and it's location. Offshore Borrow Sites will be carried into the final array of alternatives. See the Geotechnical Appendix and SANDAG(a) for detailed information on offshore borrow site investigations.

FIGURE 4-2 REGIONAL OFFSHORE BORROW SITES (NOT TO SCALE)



Onshore Borrow Sites

Reservoir areas behind the City of San Diego owned dams and the Nelson and Sloan quarry were investigated as potential sources of sand and beach replenishment material for the project.

Several dams owned and maintained by the City of San Diego contain reservoirs with some low potential for use as beach replenishment material. The material is mostly too fine for beach material and is also located in environmentally sensitive areas behind the reservoirs of the dams, where any disturbance would constitute a major impact.

In 1980, there were a dozen sites mining sand, but they have all been closed for various environmental reasons or they just simply mined all of the sand out of the river bottoms within their mine limits. The Nelson and Sloan quarry is located approximately 7 km (4-1/2 miles) southeast of Imperial Beach, just north of the Mexico border and along the south boundary of the Tijuana River flood plain. The quarry has supplied previous Corps projects with rip-rap. Some potential for beach replenishment material exists within the quarry and the surrounding area, although the cost would be much higher than offshore sources, and the amount of material that could be processed is not likely to meet the project needs.

Phone conversations with local sand and gravel miners and suppliers indicate that any amount of beach suitable sand over 10,000 cubic yards would be very hard to find in San Diego County. There is very little mining availability left within San Diego, and almost all of the sand used for concrete is imported. Some sand is barged up from Ensenada, Mexico into San Diego Harbor, and some is also imported from Riverside and San Bernardino Counties, but the cost averages around $35 per cubic yard due primarily to transportation costs.

Due to these severe constraints and significant costs, onshore borrow sites will not be carried forward into the final analysis.

4.5.2.2 Managed Retreat

Managed Retreat is a term commonly used to describe a policy that restricts or opposes efforts to control long term retreat of the shoreline. It has been used to describe policies ranging from complete removal of all shore protection structures to simply not allowing new structures to be built. The Corps study authority in Segments One and Two is directed at protecting property and structures from coastal storm damage, which would seem inconsistent with a policy of not protecting property and structures from coastal storm damage.

However, an analysis was performed to determine the actual structural damages that would occur to unprotected parcels if a ban on new seawalls was implemented. This analysis assumes a ban on new structures and removal of all existing structures in 50 years. (Existing structures would remain in place through the period of analysis.) Costs consist of blufftop structural damages and blufftop land loss damages.

This analysis, discussed in section 3.3.7 above, indicates that these damages are more than twice the cost of protection. **Table 4-1**, below, shows these projected average annual damages from land loss and loss of blufftop structures.

Table 4-1 Projected Damages – No New Seawalls Scenario

Reach	Structure Damages	Land Damages
1	$0	$0
2	$2,500	$20,100
3	$270,700	$647,800
4	$252,200	$544,000
5	$160,800	$385,100
6	$0	$0
8	$461,300	$678,400
9	$1,142,400	$1,061,100
Total	$2,289,900	$3,336,500

No damages are shown in Reach 1 because nearly all parcels in Reach 1 that are subject to wave attack have been armored. No damages are shown in Reach 7 because those damages are not related to armoring and land loss. Damages in Reach 6 are near zero because there is extensive armoring and few structures to begin with.

In this scenario, homeowners would have to be compensated for their property loss as a "regulatory taking". The local sponsors have indicated that they do not have the resources to provide this compensation on the scale required, and thus cannot support Managed Retreat. Advocates of Managed Retreat in the study area are now looking at longer term strategies beyond the period of analysis that should not have an impact on Federal Project Plan Formulation.

Therefore, there is very little likelihood of a complete ban and/or removal policy being adopted during the project design life. There is also very little likelihood that existing privately built seawalls will have to be removed during the project design life. As a policy or measure, Managed Retreat is more appropriately addressed under the Corps Environmental Restoration authority, or by local governments using regulatory and permitting authority to restrict development. Managed Retreat is not carried into the final analysis.

4.5.2.3 Best Management Practices – Subaerial (groundwater and runoff induced) Erosion

Subaerial processes both weaken the underlying bluff structure and contribute to runoff erosion on the surface of the bluff face. Along the study area shoreline, the rate of blufftop retreat caused by runoff is extremely low when compared to the rate caused by wave attack. The local sponsors have already implemented a regime of codes and ordinances to enforce Best Management Practices to reduce groundwater seepage and subaerial erosion, therefore this will occur both with and without a Federal Project, and does not play a role in plan selection or NED analysis.

4.5.3 Structural Measures – Sand Retention

The effectiveness and design of sand retention structures has been studied and documented extensively in Coastal Engineering literature over the last 30 or 40 years. Innumerable empirical relationships have been developed in the laboratory and the field to try to predict the equilibrium shoreline created by a structure of given dimensions at a given location for various conditions. The most recent and relevant of these studies is The SANDAG "*Regional Beach Sand Retention Strategy*" of Oct.,2001, prepared by Moffatt & Nichol Engineers, and discussed in the Coastal Engineering Appendix. This study provides valuable guidelines and recommendations specific to the region.

The sand retention structures discussed below are only considered in conjunction with a beach replenishment component, because there is little net sand transport in the littoral cell, so the structure would likely trap very little sand without mechanical nourishment. This dependency is described further in the coastal engineering appendix. The three main classes of sand retention structures and reasons for their inclusion or exclusion from the final analysis are given below;

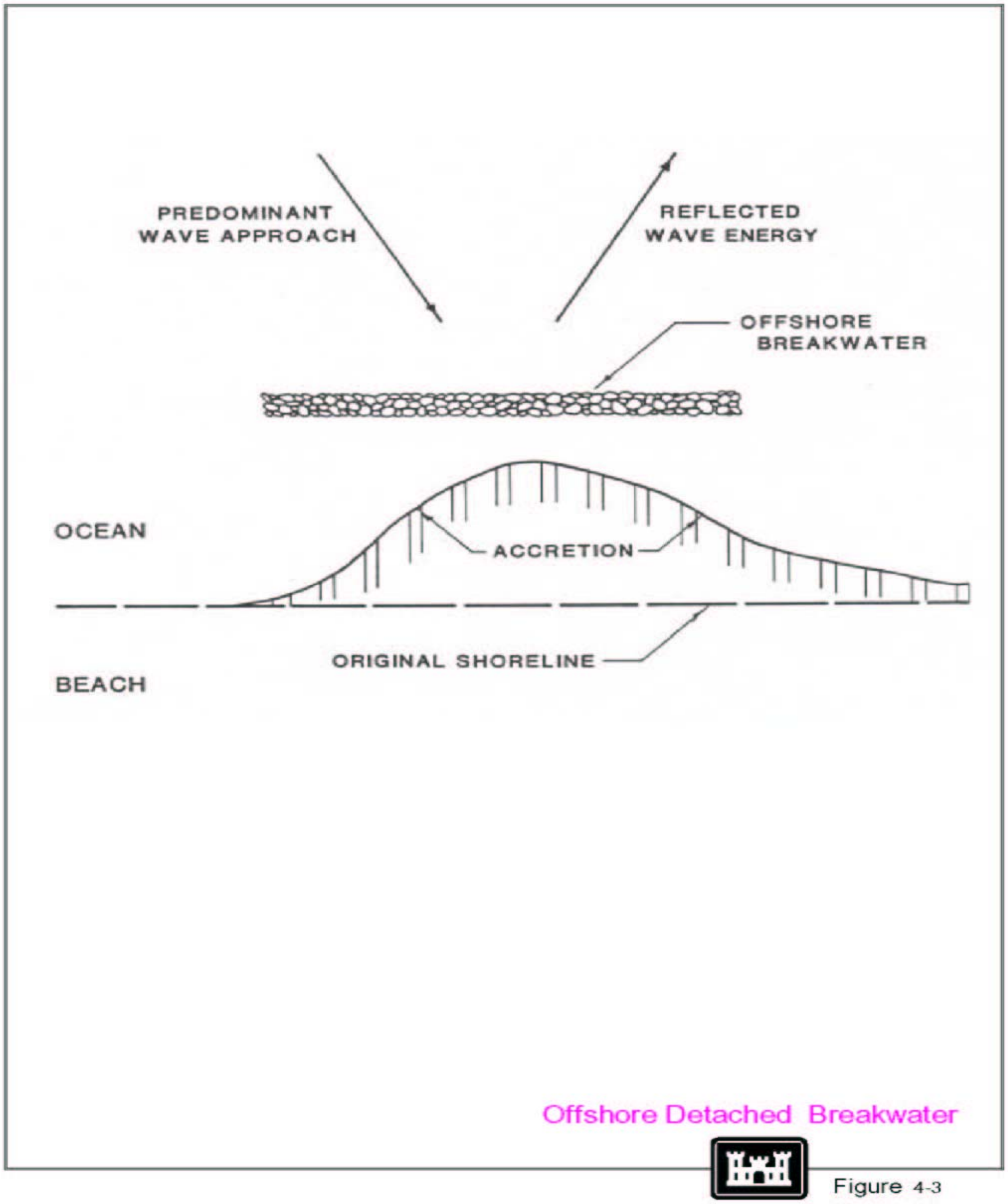
4.5.3.1 Visible (Surface Piercing) Breakwaters

Breakwaters are concrete or rock walls built roughly parallel to the shore just beyond the breaker zone to absorb wave energy by stopping transmission or breaking the wave before it hits the beach. They can be permeable or solid, depending on desired amount of wave energy absorption vs. reflection. Preliminary cost estimates were developed by SANDAG for a 50 year life, 1,000 foot long breakwater, with enough beach replenishment to create a 17 acre beach in the lee of the breakwater (SANDAG - citation). The $33 million cost included 1.1 million cubic yards of sand initially and an additional 620,000 cubic yards on a 10 year nourishment cycle. Visible breakwaters were considered, however they were screened out of the final analysis for several reasons;

- public safety issues
- extremely high cost,
- impact on down coast littoral transport
- impact on surfing
- impact on aesthetics, and most importantly,
- lack of support from the local sponsor and local community.

The concept design plan view is schematically illustrated in **Figure 4-3.**

FIGURE 4-3 TYPICAL DETACHED BREAKWATER



4.5.3.2 Submerged Breakwater/Artificial Reef

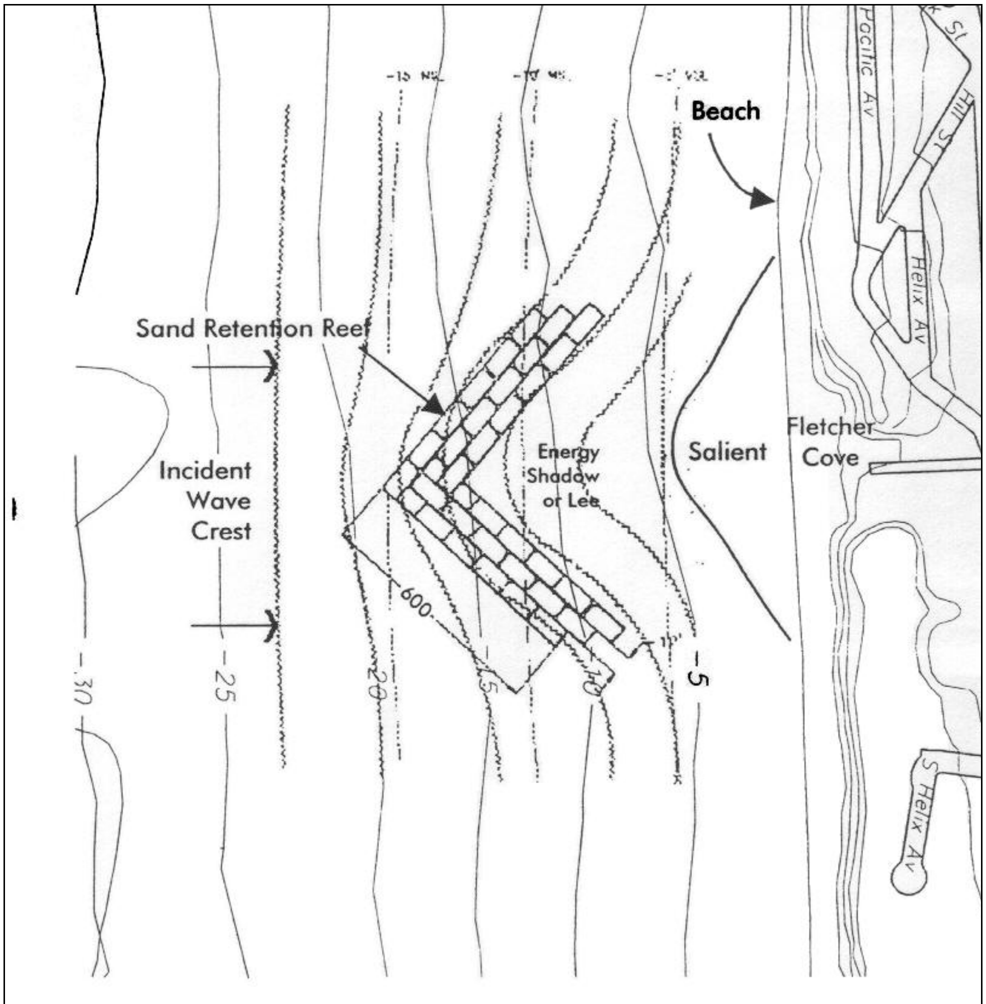
Submerged artificial reef type designs come in many forms, but can be roughly broken into "soft" and "hard" designs.

In the soft designs, nearshore sand berms are constructed of dredged sand placed parallel to the beach in shallow water. The "soft" breakwater reduces incident wave height, and gradual onshore migration of the sediment can contribute to renourishment of the adjacent shoreline, providing the berm itself is stable enough to withstand the wave environment. However, this type of design is generally not suited for the type of wave environment in the study area because the relatively small grain sizes of available sand would not be stable when subject to the wave induced bottom currents. Therefore, soft submerged berms were not carried into the final analysis.

In addition to these "soft" submerged breakwaters, "hard" submerged breakwaters which include "artificial reefs", were considered. These structures reduce wave energy through breaking and dissipation. They are generally not as effective as surface piercing breakwaters at retaining sand, but do not generally have the adverse effects on surfing conditions that surface piercing structures do, and can even enhance surfing conditions if designed for dual purpose. The "*SANDAG Beach Retention Strategy* " states on page 18 of Appendix 4, "*To effect wave dissipation, (artificial) reefs are wide in the cross-shore direction. Large and especially irregularly shaped reefs refract waves, thereby altering their approach direction toward the shoreline. Structure-induced changes in the alongshore flux of smaller reefs are due primarily to an attenuation or dissipation of wave energy as it passes over the structure….. In this… condition, the (beach width) bulge is retained in dynamic equilibrium. Reefs for sand retention and surfing are generally located nearshore with a crest (plateau) elevation near MSL. These reefs are either shore connected or offshore, each behaving very different from the other. Submerged reefs rarely generate substantial adverse effects on neighboring beaches since they have little impact on the longshore littoral drift…..*"

Although much theoretical research has been done, real world data on the performance of artificial reefs as sand retention structures is only now becoming available, because few have been built. In addition, most of those were either in Florida or Australia, where conditions differ greatly from the Southern California coastline. Pratte's Reef was constructed off El Segundo, California out of large geotube sand bags, but was ultimately too small and too far offshore to have any noticeable impact on the shoreline (M&N, SANDAG, Oct 2000). As discussed previously, another separate study, titled the "U.S. Army Corps of Engineers' National Shoreline Erosion Control Demonstration Program" is ongoing concurrently under a different authority to find innovative ways of using coastal structures to reduce or prevent beach erosion. The main focus of that study is on submerged breakwater type structures. It is hoped that new, innovative concepts and designs can address issues with existing designs such as high costs, safety, effectiveness, and impacts on surfing. The concept design is schematically illustrated in **Figure 4-4.** However, extremely high costs, coupled with extremely high uncertainty, severe local opposition to any system of offshore structures on the scale required, and the lack of support from the local sponsors have resulted in this measure being precluded from further consideration.

FIGURE 4-4 (CONCEPTUAL) TYPICAL ARTIFICIAL REEF



Source: Moffat & Nichol Engineers, 1999

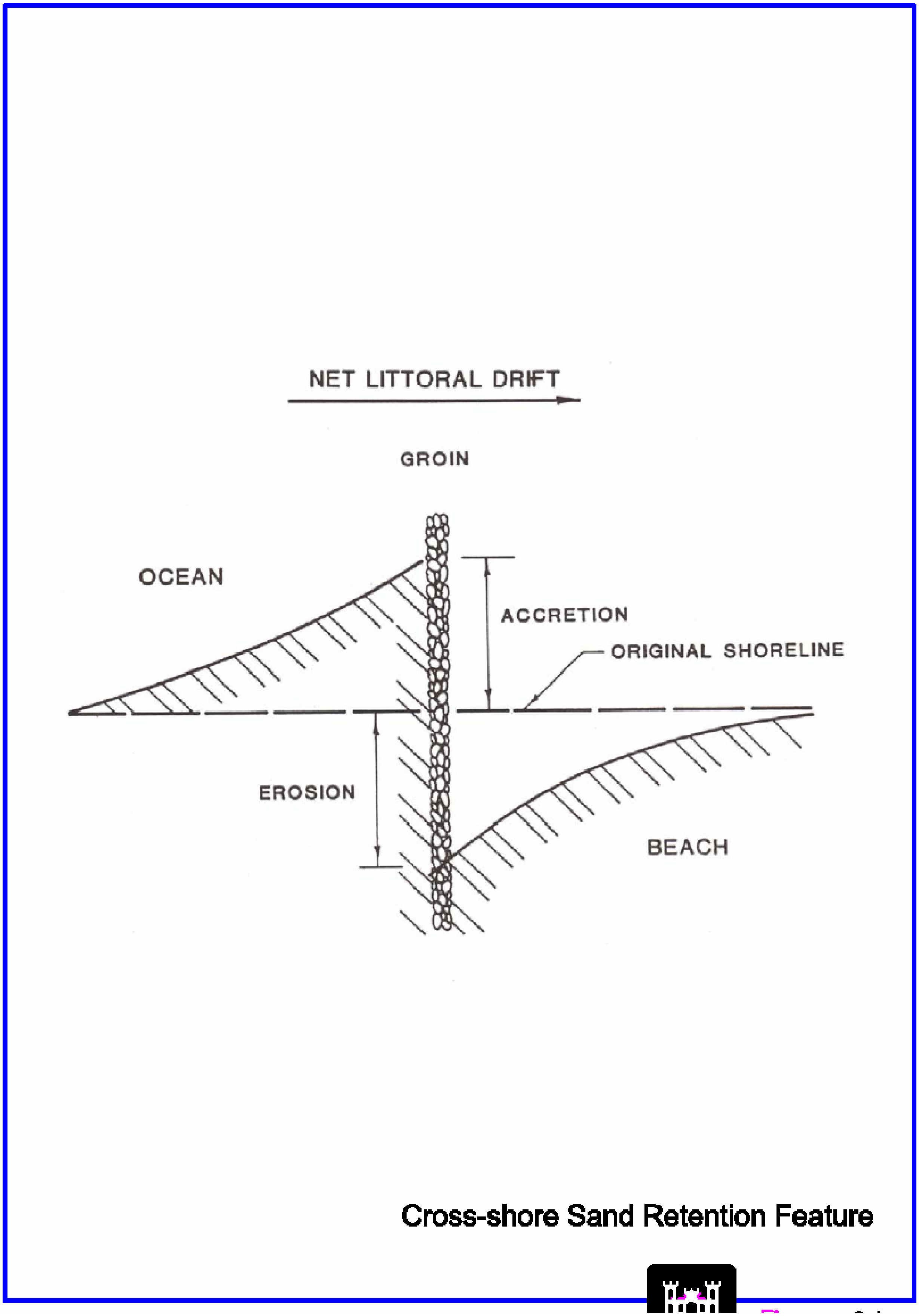
4.5.3.3 Groins

Cross-shore sand retention structures, such as groins and jetties, are constructed perpendicular to the shore to form fillets that can slow beach erosion by trapping littoral sediment. Most of the littoral drift occurs inshore of the normal breaker line under prevailing wave conditions (about the 2- to 3-meter depth contours on the Pacific coast). Hence, extension of sand retention structures beyond about MLLW is generally uneconomical (USACE, 1984).

The shore perpendicular structures are generally utilized to preserve a minimum berm width and slow erosion rates so that renourishment volumes can be lower and episodes less frequent. The amount of sand trapped by the structure depends on the permeability, height, and length of the structure and the amount of sand in the littoral system. As material accumulates on the updrift side of the structure, supply to the downdrift side is reduced. This results in local beach accretion on the updrift side of the structure and erosion for some distance downshore. After the beach near the structure adjusts to an "equilibrium" stage in accordance with the wave conditions, all littoral drift will pass the structure either directly over it or diverted around the seaward end of the structure. Because of the potential adverse effects on downdrift beaches, groins and similar structures should be used only after careful consideration of the factors involved.

Groins were considered, but this measure would entail extremely high costs, lack of public/sponsor support, severe impact on lateral beach access, potential impacts to downdrift beaches, and questions about effectiveness, because groins are not very effective in areas like the study area, with limited sand supply. This measure was screened out of the final analysis for the reasons cited above. The concept design is illustrated in **Figure 4-5.**

FIGURE 4-5 TYPICAL GROIN



4.5.4 Structural Measures – Bluff Protection

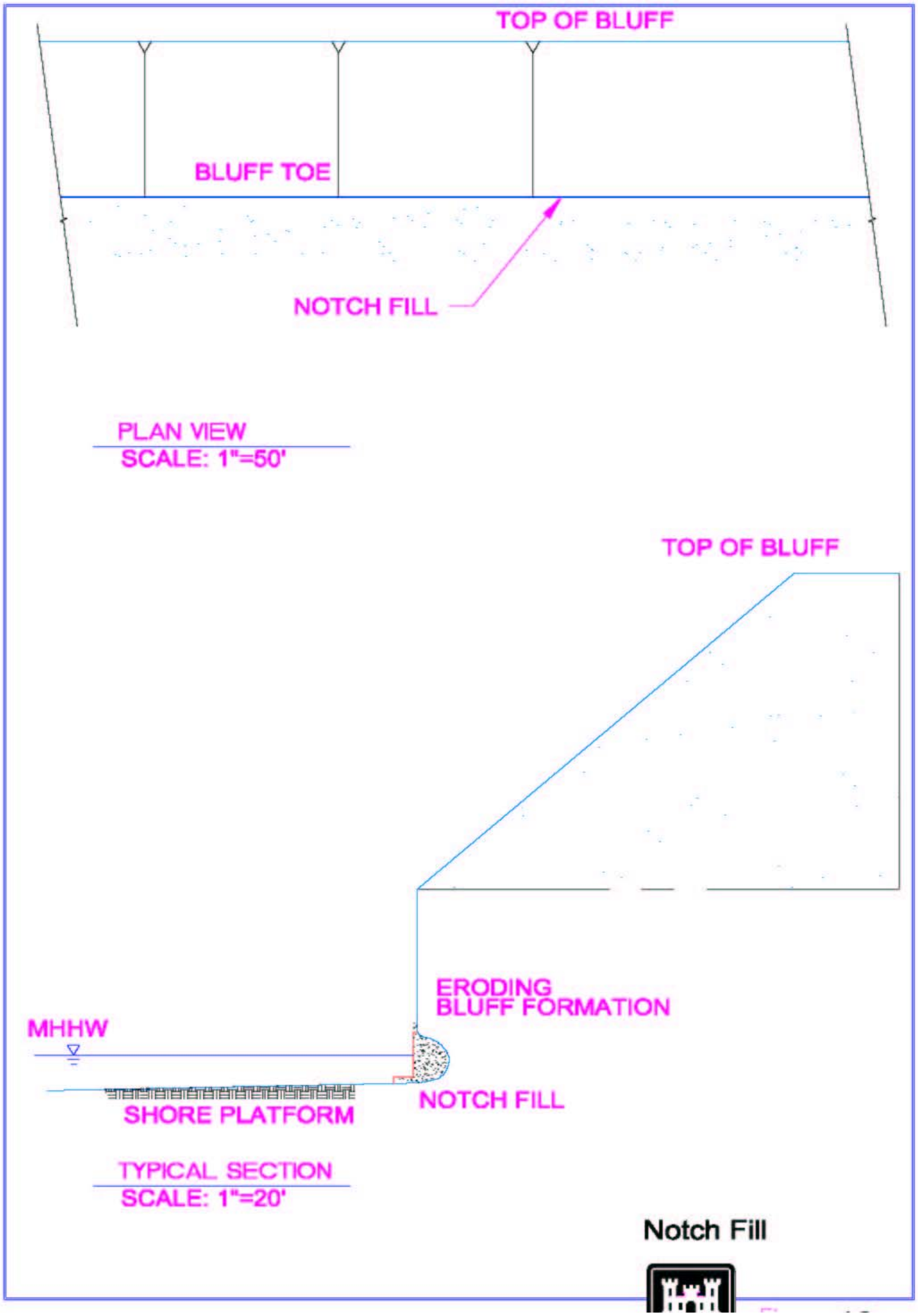
Other structural measures to protect the shoreline include those placed directly at the toe of the bluff to protect it from wave attack.

4.5.4.1 Notch Fills

Filling of small sea caves and notches with engineered concrete has proven to be a fairly effective method of stopping notch erosion. As indicated in the 1996 Corps Reconnaissance Report, notch fills effectively improve overall sea-cliff stability, arrest further erosion of the cliff base and provide vertical support of the overhang. The 1996 Reconnaissance Report discussed fill designs using reinforced concrete and constructing a 6-inch-thick shotcrete wall applied directly to the bluff face, extending up to an elevation of +4.7 meters (15 feet), MLLW. This solution has been implemented throughout portions of Reaches 3 and 4. Notch fills have also been completed recently in Solana Beach comprised entirely of erodible or low strength concrete typically having unconfined compressive strengths on the order of 800 psi. These were placed entirely landward of the drip line without the use of reinforcing steel. The erodible notch fills were keyed a minimum of 1 to 2 feet into the formational bedrock shore platform, and loose or deleterious material was removed from the notch or sea cave prior to the low-strength concrete. This measure is therefore carried forward into the final analysis.

The particular design for a notch fill is based on the geotechnical characteristics of the area and the size of the notch. The appropriate design and costs for each area are discussed in the following sections. The concept design is schematically illustrated in **Figure 4-6.**

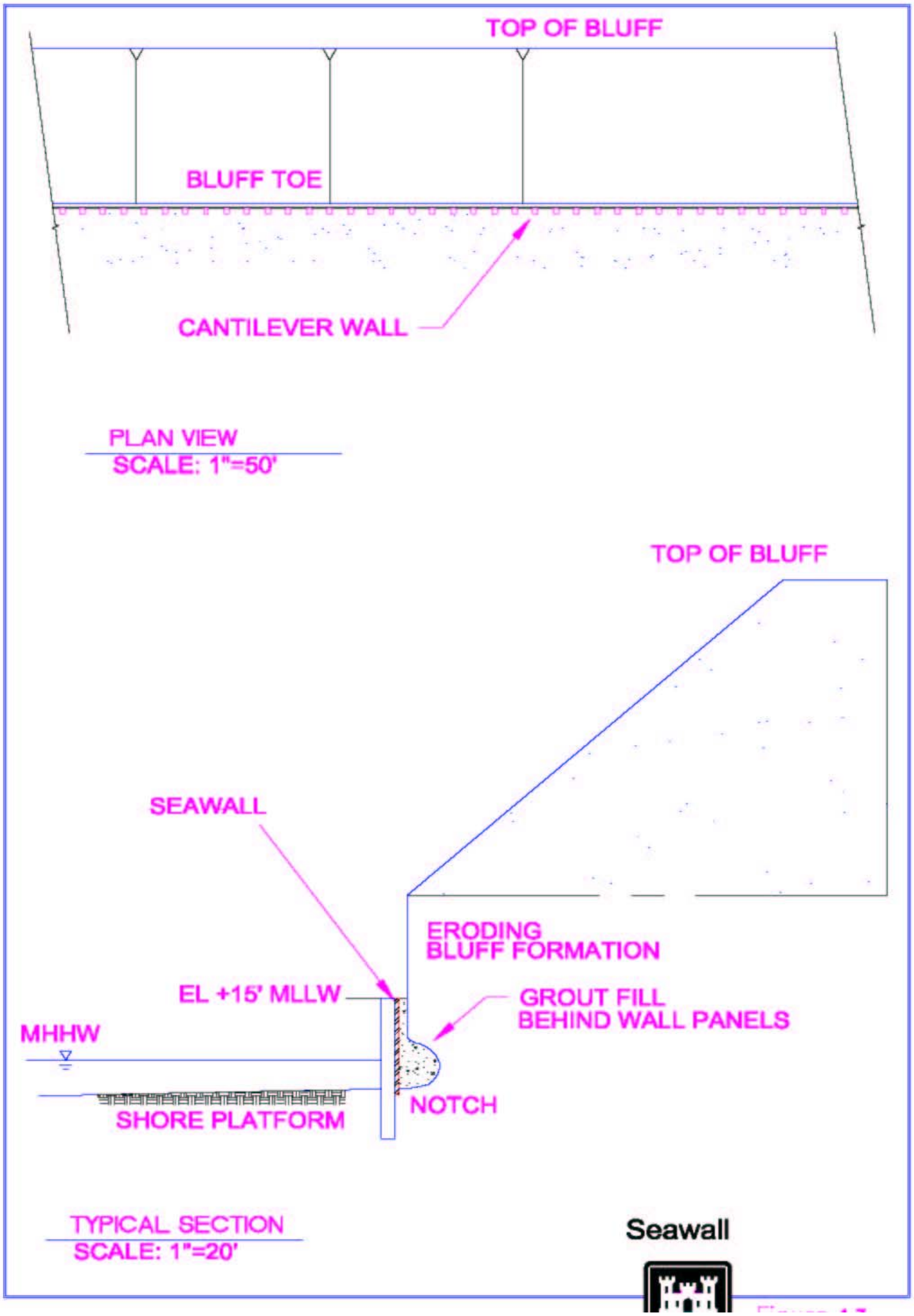
FIGURE 4-6 SCHEMATIC OF TYPICAL NOTCH FILL



4.5.4.2 Seawalls

Seawalls are solid concrete (or sometimes stone or steel) structures designed to withstand the full force of storm waves without being overtopped or undermined. The structures protect the weaker formational materials in the bluff from the direct hydraulic forces associated with breaking waves and the indirect and destructive abrasive action caused by sand and cobble thrown into suspension against the cliff toe. They are generally effective at stopping bluff erosion if maintained, but do not stop or reduce beach erosion. Because of construction access limitations and site constraints, feasible concepts are limited to cantilever or shotcrete wall designs. Numerous seawalls have been constructed in San Diego's North County, including conventional cantilevered concrete structures. These structures typically include a cut-off wall and tied-back concrete seawalls utilizing either pre-cast concrete panels set into an excavated toe trench or tied-back structural concrete walls. The structural walls are typically placed in a toe trench embedded a minimum of 1 to 2 feet into the bedrock shore platform. The particular design selection for a seawall is based on the geotechnical characteristics of the area, the bluff slope, and the size of the notch. Seawalls are carried forward into the final analysis. The appropriate design and cost for each area is developed in the following sections. A conceptual design is schematically illustrated in **Figure 4-7.**

FIGURE 4- 7 SCHEMATIC OF TYPICAL SEAWALL DESIGN



4.5.4.3 Revetments

Revetments are “flexible” structures (not locked in concrete) made of placed quarry stone designed to protect the bluff toe from erosion by wave action. They are typically built of 3 to 5 ton stone over a layer of smaller stone over a layer of fill. Revetments are generally effective if maintained, but encroach significantly onto the beach.

In Solana Beach there is a large lens of unconsolidated sand in the mid-bluff zone which is not present in Encinitas. Any stabilization measure in Solana Beach must therefore extend significantly higher up the bluff face than in Encinitas. For this reason, revetments are impractical in Solana Beach because their footprint would extend over 60 feet seaward of the bluff toe, which is an unallowable impediment to coastal access and recreation. Revetments may be effective in Encinitas, where the bluff geology may be more suitable. However, because of the reasons listed below, revetments were eliminated from further consideration as a shore protection measure:

Aesthetic Impacts - Revetment is less aesthetically pleasing than beach replenishment or notch fill or seawall. The length of shoreline affected would have significant impacts on aesthetics throughout the study area.

Public Access Impacts - Revetments are difficult and hazardous for pedestrians to cross and severely impede access to the beach. In addition, they take up a signficant portion of the beach width and impede alongshore access, constituting a significant impact to public access.

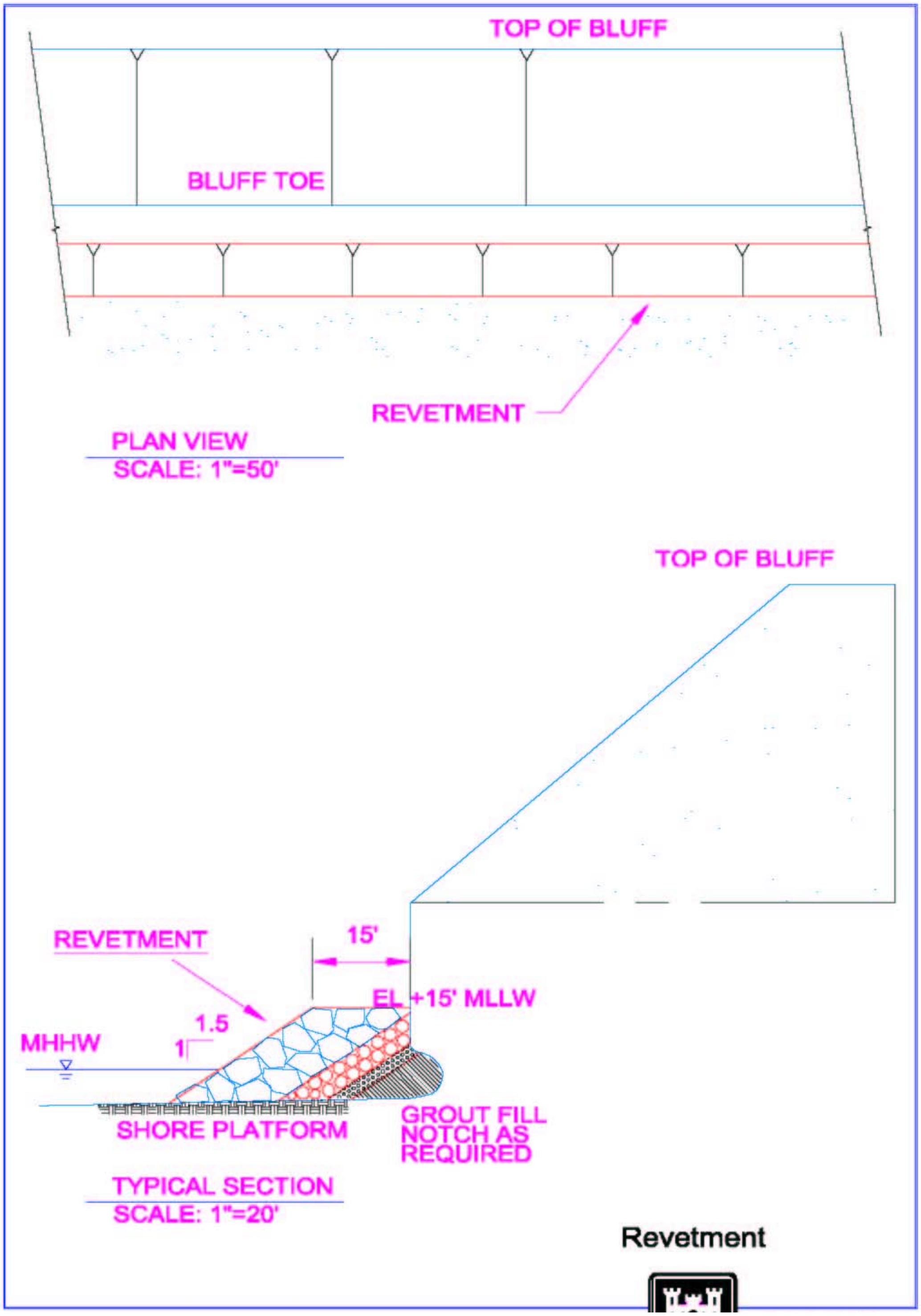
Recreation Impacts - Revetments would extend seaward up to 10 meters from the bluff toe in Encinitas and 20 m from the bluff toe in Solana Beach. This would result in no beach in the winter and would severely limit available beach space in the summertime and would constitute a significant impact.

Major Issues re: Consistency with Coastal Act - The California Coastal Commission currently interprets the Coastal Act in such a way that favors almost any type of shore protection over rock revetment, especially in areas where there is a lot of public beach use and recreation. A Revetment project of this size would have very little chance of obtaining a Coastal Consistency Determination.

Severe Public Opposition from Well Organized Groups (SPOWOG). - Local, well organized and well funded citizens groups including Surfrider have expressed strong opposition to revetments both in public meetings and in litigation. Any proposed project including revetment would encounter severe opposition from these groups

The conceptual design is schematically illustrated in **Figure 4-8.**

FIGURE 4-8 SCHEMATIC OF TYPICAL REVETMENT



4.5.5 Selected Reaches (Segments One and Two)

The preliminary analysis indicates that Reaches 3, 4, 5, 8, and 9 are the only reaches experiencing significant storm related damages (see Chapter 3). Reaches 1 and 2 experience some erosion, but it is nearly all related to landslide activity, not wave attack or storm flooding. Reach 6 has few blufftop structures, and is almost completely protected. In Reach 7, although there are some travel delays, flooding, and wave damages, these are not great enough to incrementally justify the cost of a federal project *at this time*. However, Hwy 101 is designated part of the Strategic Highway Network by the U.S. Dept of Defense, and there may be other Federal authorities that can be used to provide protection of Reach 7 for this reason. In addition, the restoration of San Elijo Lagoon is expected to provide incidental protection benefits to this reach through the proposed placement of accumulated beach compatible lagoon sediments on the beach in Reach 7. Table 4-2 displays the total average annual storm damages by Reach.

Table 4-2 Total Annualized Costs/Damages by Reach –W/out Project

Reach	Annualized Damages
1	$0
2	$19,629
3	$164,817
4	$325,406
5	$467,081
6	$327
7	$11,800
8	$375,792
9	$423,695
Total	$1,788,548

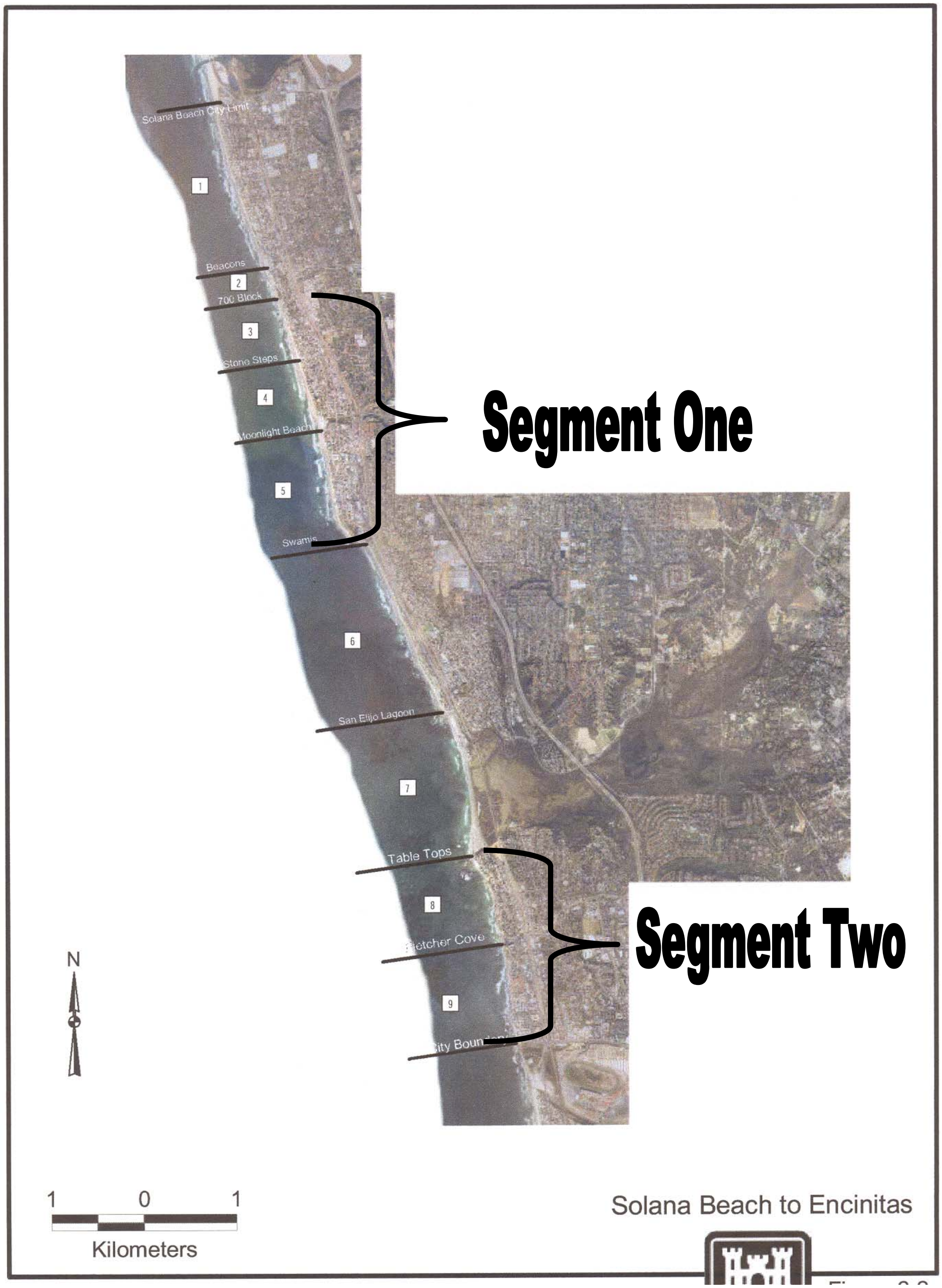
Due to the high costs of effective, long lasting shore protection measures, only Reaches 3, 4, 5, 8, and 9 are candidates for Federal assistance at this time. This covers about 5.5 kilometers, or almost half of the study shoreline. For purposes of project benefit and cost analysis, Reaches 3, 4, and 5 may be considered one contiguous segment and Reaches 8 and 9 may be considered another. Reaches 3, 4, and 5 comprise approximately 3.2 kilometers of the Encinitas shoreline and are designated **Segment One**, and Reaches 8 and 9 comprise about 2.3 kilometers of the Solana Beach shoreline and are designated **Segment Two**. Table 4-3 below displays the average annual storm damages for just those Reaches.

Table 4-3 Annualized Damages by Reach

Reach	Annualized Damages
3	$164,817
4	$325,406
5	$467,081
8	$375,792
9	$423,695
Total	$1,756,791

Figure 4 – 9, below, shows the approximate extent of Segments One and Two relative to the study reaches.

FIGURE 4-9 SEGMENTS ONE AND TWO



4.6 FINAL ALTERNATIVES DESCRIPTIONS

Excluding the No Action Alternative, three different measures were found suitable for further analysis; beach replenishment, toe notch fill, and seawalls.

An assessment of the dependence and separability of different combinations of these three measures yielded three possible permutations that could meet the planning objectives and satisfy all or most of the planning criteria. These combinations are designated Alternatives 1 through 3, and are described below.

4.6.0 Alternative 0 – Shoreline; Future Without Project – Private Piecemeal Protection

General Description

Under the Future Without Project Scenario, the assumption is made that existing seawalls will continue to be maintained, and private homeowners will continue to be granted emergency permits to build new ones. Reach 7 will continue to suffer flooding damages and Hwy 101 closures. Most of the shoreline will be armored within 20 or 30 years, but in a costly, inefficient, uncoordinated patchwork after significant loss of land. Assumptions, costs and impacts of this alternative have been presented previously in this document and are detailed in the Economics Appendix.

4.6.1 Alternative 1 – Beach Nourishment

By creating a wide beach where there currently is little or no sand, storm protection is provided to the shoreline both by reducing wave energy and by creating a sacrificial beach to be eroded during a storm. Periodic sand replenishment is necessary to maintain the beach buffer over the project life. Other benefits of beach fill include providing additional recreation opportunities and, potentially, improving habitat for endangered species. This approach directly addresses the deficit of sand in the system without making it worse in adjacent reaches, and is therefore a benign approach to beach erosion. This practice is supported by the National Research Council (1995), which has strongly endorsed beach fill and has issued substantial design guidelines.

4.6.2 Alternative 2 – Hybrid Toe Protection Plus Beach Replenishment

Rationale for Hybrid Plan

The minimum beach widths and replenishment episodes necessary to ensure full time protection of the bluff toe were established for Alternative 1, Beach Nourishment. Reducing the beach width any further or extending the time between replenishments would likely result in the bluff toe being exposed to wave attack periodically, especially if the replenishment episode is delayed for any reason (permitting process, funding availability). In addition, unusually high storm activity between replenishments could result in complete loss of the frontage beach for one or two seasons. Therefore, an alternative was developed which incorporates a narrower beach design with minimal protection of the bluff toe. The toe protection involves filling in notches and seacaves at the bluff of the toe to stabilize the bluffs and prevent wave-induced erosion and undermining during occasional periods of beach degradation. This reduces the cost of the alternative significantly without affecting the project benefits.

4.6.3 Design Parameters for Alternatives 1 and 2

With any alternative that has a beach-fill element, an optimization analysis in accordance with the Corps design guidelines is required to determine the most cost-effective combination of an initial design berm width and a repetitive duration for the subsequent replenishment cycles. Typically, hurricane and storm damage reduction plans that employ sand fill are formulated by first determining the economically optimal design section. Normally, this is accomplished by evaluating design sections that vary the width and elevation of the design berm. Once the optimum design profile is established, analyses are done to determine the optimum advance nourishment and periodic nourishment schedule. The NED plan is that which optimizes both the design profile and nourishment schedule. Advance maintenance material is considered sacrificial. Its purpose is to help maintain the integrity of the design section over the period of Federal participation in the project. *If the design profile is not maintained for the 50-year period of recommended Federal participation, expected damages should vary each year during the period of evaluation.* Typically the NED plan design section is identified and maintained for the period of Federal participation rather than allowing different levels of protection for each year of the evaluation.

In this analysis, a modified optimization procedure was used for Alternatives 1 and 2. All feasible permutations of various beach-fill widths and different replenishment cycles were evaluated and compared. The width and replenishment cycle were varied over a wide enough range to ensure maximum net benefits even if it meant residual damages from toe erosion. The range of widths was selected to bracket the "non-damaging" width of 50 m, ensuring that the NED plan would be included within the range. Each option represents one combination of an initial beach width and a replenishment cycle. The beach is restored to its initial design width at the beginning of each replenishment cycle. This methodology allows identification of plans producing cost savings greater than their residual damages, resulting in higher net benefits.

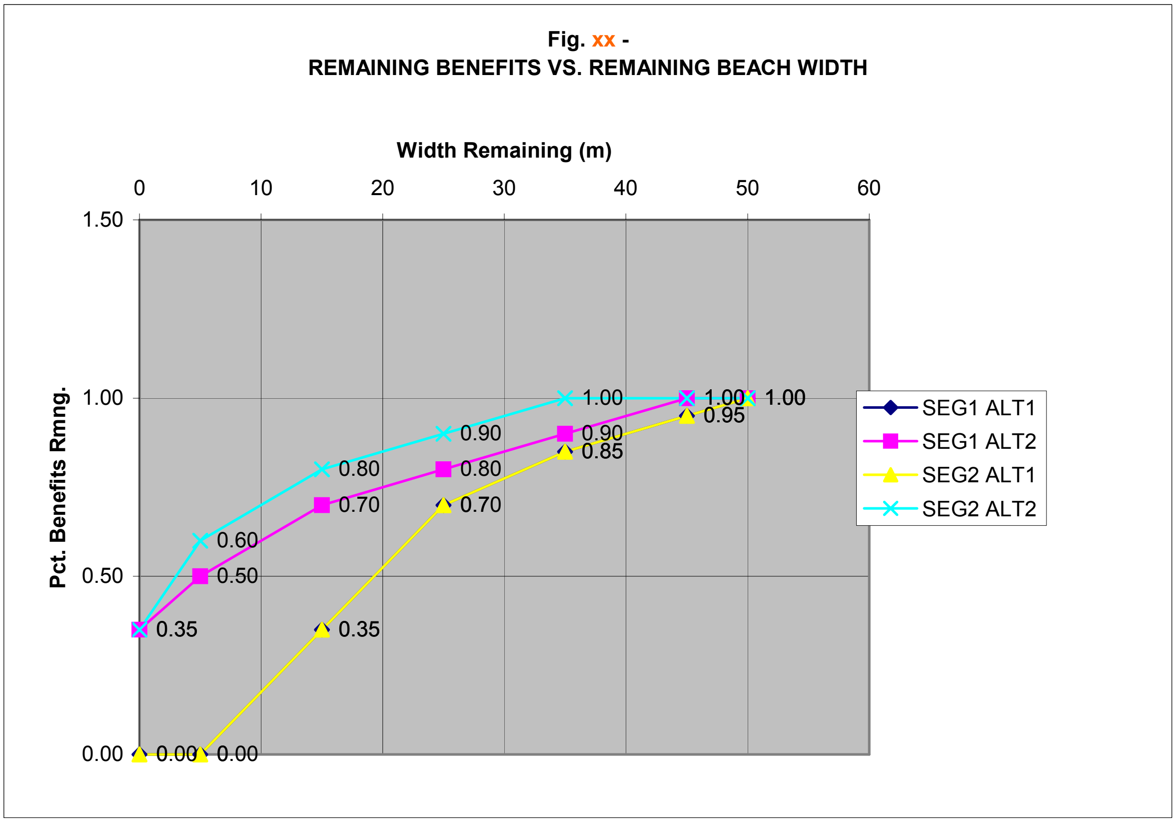
Sixty Four (64) Permutations

64 permutations (eight beach widths - 90, 80, 70, 60, 50, 40, 30, and 20 meters, times eight different replenishment cycles- one to eight years) were evaluated to determine the optimal width and cycle for each segment. For each of the 64 permutations, the GENESIS software modeling package was used to predict shoreline morphology for an eight year period after replenishment.

Under some of the 64 permutations, the bluff toe is occasionally exposed in some parcels towards the end of the replenishment cycle, when the beach is narrower. Under with project conditions, it is assumed that property owners would not be granted emergency construction permits (from California Coastal Commission) for seawalls, and some toe erosion may occur. If this toe erosion reaches the threshold, residual damages may occur in the form of land loss on the bluff-top as block failures are triggered.

Because no site specific field data were available regarding residual damage vs. beach width, some assumptions were required to develop an empirical relationship such as a formula or curve which could be used to estimate residual damages as a function of remaining beach width. It was determined that a graphical representation was best suited for the task.

Figure xx, below, shows a graphical representation of these residual damages factors by segment and alternative. The Economic Appendix contains a detailed description regarding how these curves were derived.



The project costs for all 64 permutations include mobilization/ demobilization, the unit price of dredged, transported and placed sands for the initial fill and subsequent sand replenishments, and associated costs including PED, S&A, and EDC. Table 4-4 shows a tabular representation of the total costs for each permutation for Alternative 1 in Segment 1. A similar table was developed for both alternatives in each Segment.

Table 4-4 Cycle Alternative costs

Initial Width	Replenishment Cycle (Year)							
(Meters)	1	2	3	4	5	6	7	8
90	$47,649,372	$33,599,372	$27,904,082	$24,283,013	$21,898,086	$20,389,410	$19,317,679	$18,467,825
80	$46,712,023	$31,344,540	$25,840,710	$22,263,829	$19,854,588	$18,517,085	$17,644,426	$16,797,672
70	$41,959,415	$29,016,059	$23,740,158	$20,213,625	$17,882,454	$16,639,865	$15,981,423	$15,143,148
60	$39,317,017	$26,744,860	$21,618,361	$18,186,686	$15,996,553	$14,828,730	$14,328,669	$13,514,672
50	$36,808,672	$24,529,943	$19,357,466	$16,255,685	$14,181,016	$13,131,631	$12,648,267	$11,890,405
40	$34,605,197	$22,168,730	$17,007,277	$14,391,603	$12,351,611	$11,440,427	$11,013,961	$10,317,497
30	$31,962,798	$19,357,445	$14,540,236	$12,345,277	$10,516,259	$9,759,013	$9,338,659	$8,739,379
20	$31,025,450	$18,420,096	$13,602,888	$11,407,928	$9,578,910	$8,821,665	$8,401,310	$7,802,030

Next, the curves in Figure X above were employed to calculate the total benefits for each permutation. Table 4-5 shows the total benefits for each permutation for Alternative 1, Segment 1.

Table 4-5 Alternative Cycle Benefits

Initial Width	Replenishment Cycle (Year)							
(Meters)	1	2	3	4	5	6	7	8
90	$24,245,499	$22,675,976	$21,786,781	$21,243,485	$21,138,448	$20,743,049	$19,776,585	$18,104,440
80	$23,225,913	$21,985,386	$20,863,782	$20,374,211	$20,465,364	$19,890,678	$18,808,915	$17,299,758
70	$22,432,700	$21,101,021	$19,921,464	$19,559,267	$19,657,060	$19,207,935	$17,825,548	$16,427,466
60	$21,507,889	$19,864,720	$18,718,365	$18,583,145	$18,658,603	$18,148,508	$16,731,712	$15,520,162
50	$20,108,600	$18,201,026	$17,390,308	$17,209,813	$17,223,093	$16,820,450	$15,643,309	$14,383,465
40	$17,894,366	$16,178,154	$15,646,931	$15,191,769	$15,291,373	$15,179,696	$13,939,773	$12,902,077
30	$14,422,100	$13,628,283	$13,219,604	$12,925,017	$13,061,444	$13,002,285	$11,828,766	$10,978,809
20	$10,501,312	$10,195,255	$9,958,619	$9,797,442	$9,900,064	$9,952,583	$9,286,743	$8,422,298

Net benefits were calculated by subtracting the total costs in Table xx from the total benefits in Table 4-6. The following table shows the total net benefits for each permutation for Alternative 1, Segment 1.

Table 4-6 Alternative Cycle Net Benefits

Initial Width	Replenishment Cycle (Year)							
(Meters)	1	2	3	4	5	6	7	8
90	-$23,403,874	-$10,923,396	-$6,117,300	-$3,039,528	-$759,638	$353,639	$458,906	-$363,384
80	-$23,486,111	-$9,359,153	-$4,976,928	-$1,889,618	$610,776	$1,373,592	$1,164,488	$502,086
70	-$19,526,715	-$7,915,038	-$3,818,694	-$654,358	$1,774,606	$2,568,070	$1,844,125	$1,284,318
60	-$17,809,127	-$6,880,140	-$2,899,995	$396,459	$2,662,050	$3,319,778	$2,403,043	$2,005,490
50	-$16,700,072	-$6,328,917	-$1,967,158	$954,127	$3,042,078	$3,688,820	$2,995,042	$2,493,060
40	-$16,710,831	-$5,990,576	-$1,360,346	$800,166	$2,939,763	$3,739,269	$2,925,812	$2,584,581
30	-$17,540,699	-$5,729,161	-$1,320,632	$579,740	$2,545,185	$3,243,272	$2,490,107	$2,239,430
20	-$20,524,138	-$8,224,841	-$3,644,268	-$1,610,486	$321,154	$1,130,918	$885,433	$620,268

This methodology was employed to analyze each permutation for each alternative and both segments. The results indicate that the optimal replenishment cycle for both segments is 5 years and the summary results for the beach widths are given for Alternatives 1 and 2 in **Table 4-7** - below. Widths are in meters from the bluff toe to the seaward edge of the design beach berm. In practice, the footprint of beach replenishment is difficult to control with great accuracy. The figures below represent target design widths, not final specifications.

Table 4-7 Optimized Beach Widths, Alternatives 1 and 2

SEGMENT	ALT. 1 Width	ALT. 2 Width
One	70m	60m
Two	40m	30m

4.6.4 Site Specific Description- Alternative 1

In Segment 1, sand placement would occur along 2.36 km (1.5 mi) of shoreline, and the top of the berm would be constructed to an elevation of approximately +3.9 meters (+12.8 feet) Mean Lower Low Water (MLLW). The berm would be flat and approximately 70 meters wide. The beach fill would then naturally slough seaward approximately 48 meters (155 feet) at a slope of 10:1 (horizontal distance:vertical distance). The beach fill will be tapered into the existing beaches to the north and south of the segment.

In Segment 2, sand placement would occur along 2.2 km of the shoreline, and the top of the berm would be constructed to an elevation of approximately +3.9 meters (+12.8 feet) Mean Lower Low Water (MLLW), and will be flat and approximately 40 meters wide. The beach fill would then naturally slope seaward approximately 40 meters (125 feet) at a slope of 10:1 (horizontal distance:vertical distance). The beach fill will be tapered into the existing beaches to the north and south of the segment.

Environmental constraints of potential impacts on the existing rock habitats and surfing break in the reef areas also preclude any sand placement within the immediately adjacent reef areas. The footprint of the proposed nourishment reflects these constraints. The footprint of Alternative 1 is shown for Segments 1 and 2, respectively, in **Figures 4-10** and **4-11**, below, (designated "Beach Only Alternative") on the figure. The two blue lines represent the top of the beach berm and the expected toe of the beach berm at completion of construction for Alternative 1.

FIGURE 4-10. BEACH FOOTPRINTS SEGMENT ONE, ALTERNATIVES 1 AND 2

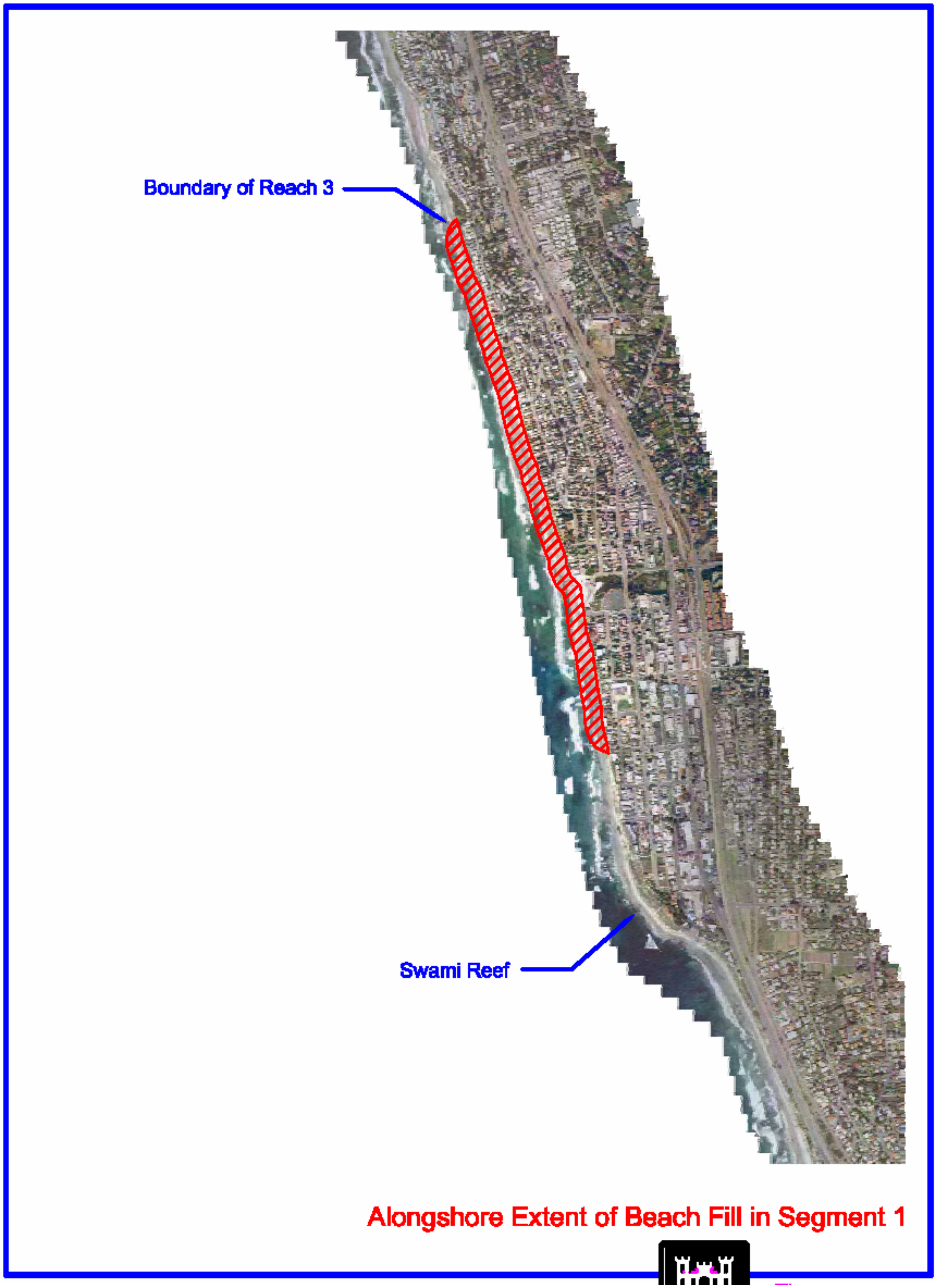
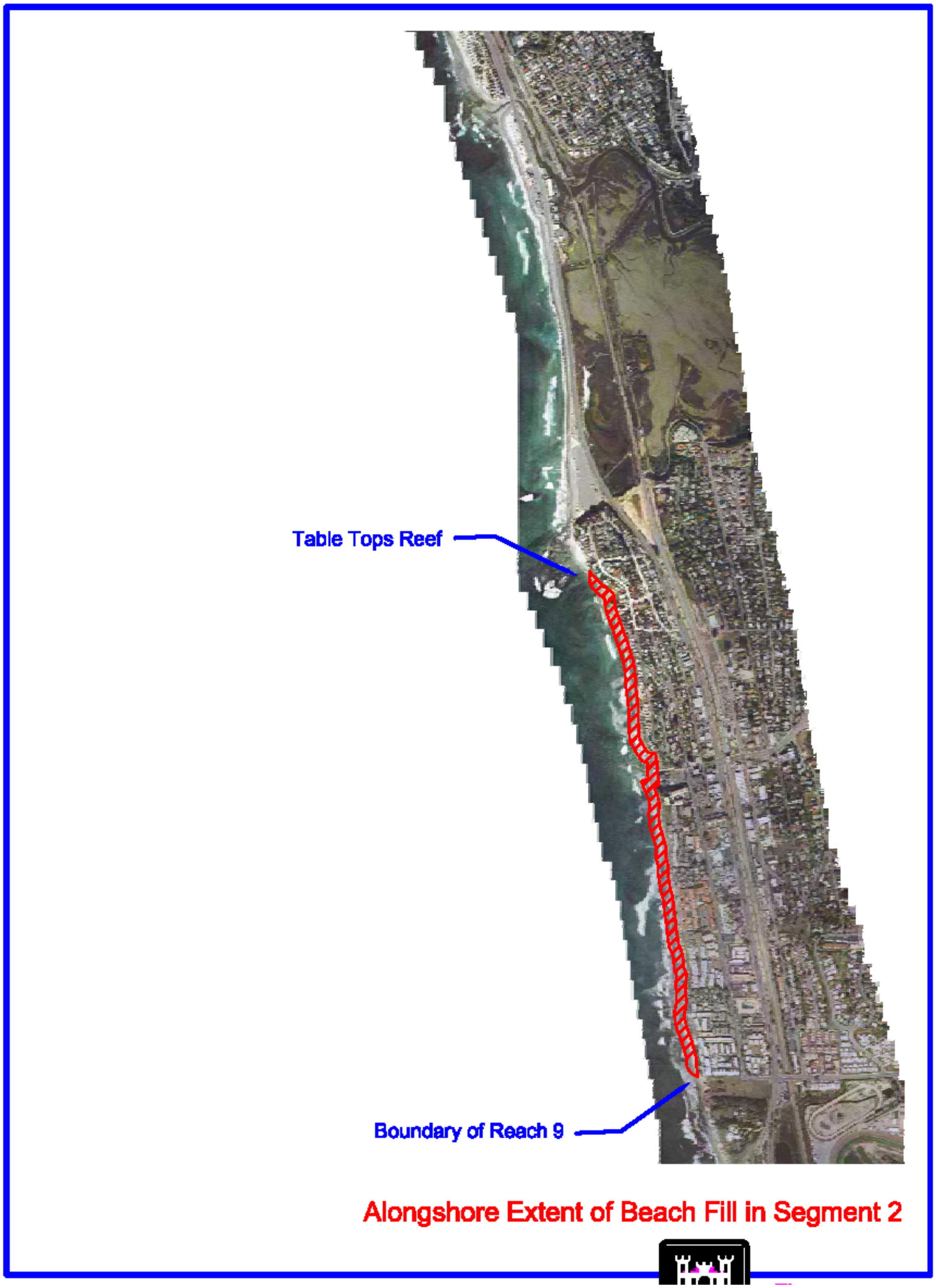


FIGURE 4-11. BEACH FOOTPRINTS SEGMENT TWO, ALTERNATIVES 1 AND 2



4.6.5 Site Specific Description- Alternative 2

Alternative 2 consists of an extensive notch fill with erodible concrete at the bluff base and placement of a 60-meter wide beach fill in Segment 1 and a 30-meter wide beach fill in Segment 2. The lower bluff protection is limited to filling notches or seacaves at the base of the bluff to stabilize the lower bluff, and does not include seawalls or upper bluff stabilization measures.

In Segment 1, sand placement would occur along 2.36 km (1.5 mi) of shoreline, and the top of the berm would be constructed to an elevation of approximately +3.9 meters (+12.8 feet) Mean Lower Low Water (MLLW). The berm would be flat and approximately 60 meters wide. The beach fill would then naturally slough seaward approximately 43 meters (134 feet) at a slope of 10:1 (horizontal distance:vertical distance). The beach fill will be tapered into the existing beaches to the north and south of the segment.

In Segment 2, sand placement would occur along 2.2 km of the shoreline, and the top of the berm would be constructed to an elevation of approximately +3.9 meters (+12.8 feet) Mean Lower Low Water (MLLW), and will be flat and approximately 30 meters wide. The beach fill would then naturally slope seaward approximately 38 meters (119 feet) at a slope of 10:1 (horizontal distance:vertical distance). The beach fill will be tapered into the existing beaches to the north and south of the segment.

Figures 4-12 and 4-13 show the beachfill cross sections for Segments One and Two respectively and for Alternatives 1 and 2.

FIGURE 4-12 CROSS SECTION OF BEACH FILL, SEGMENT ONE

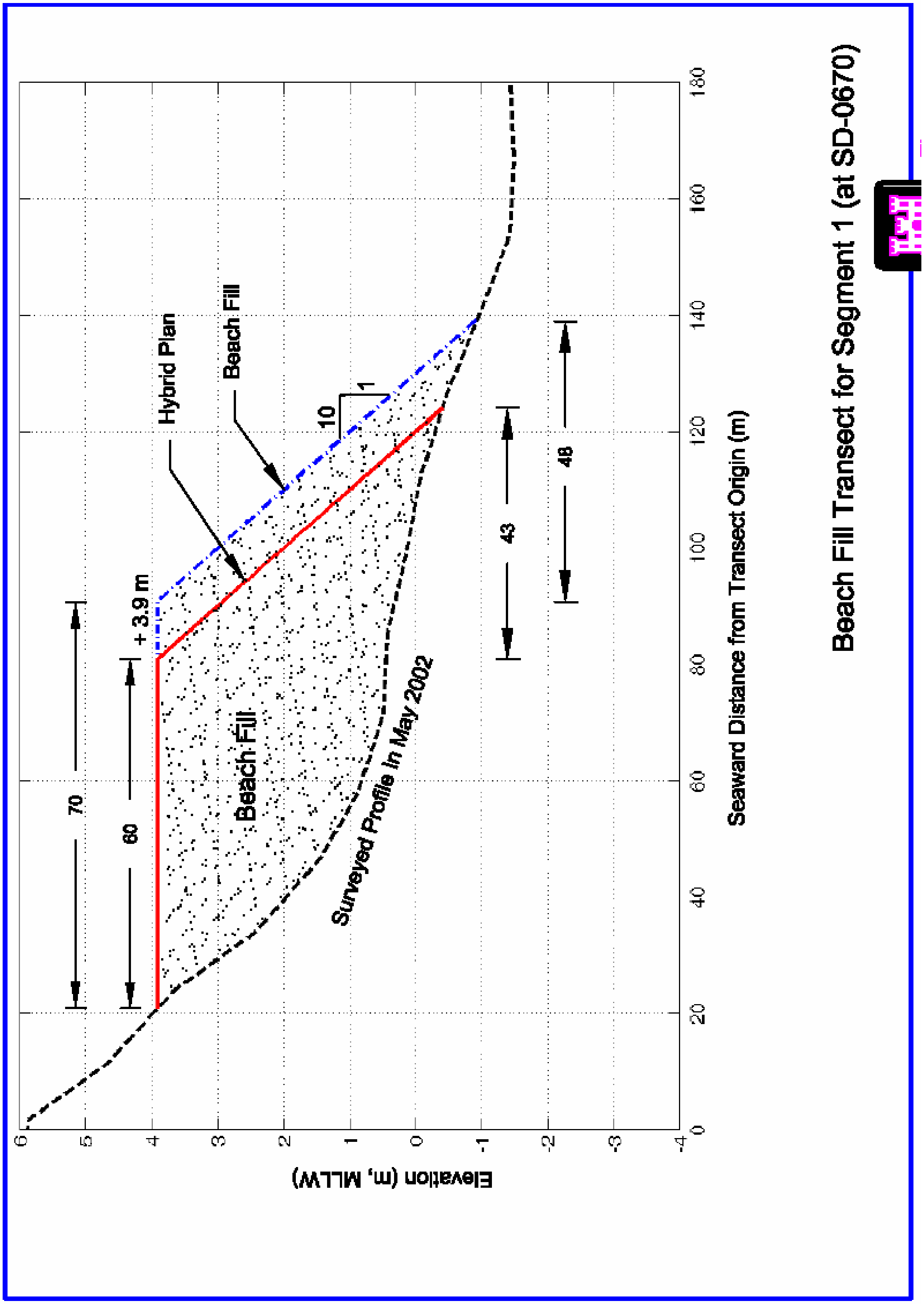
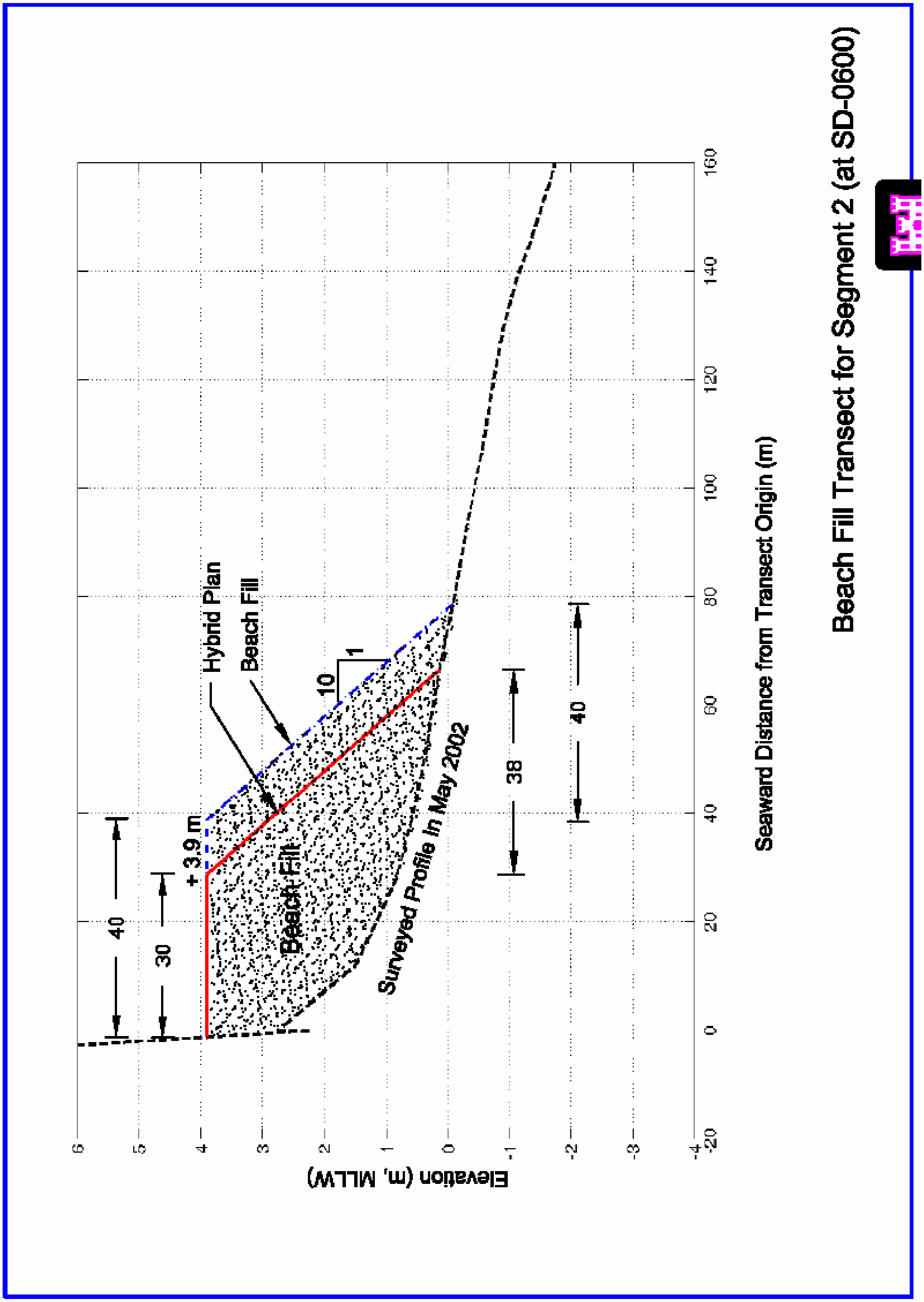


FIGURE 4-13 CROSS SECTION OF BEACH FILL, SEGMENT TWO



4.6.6 Sand Volume Analysis

For Alternative 1, total sand volume requirements for both segments combined would consist of initial placement of 1,145,600 cubic meters (1,498,500 cubic yards) and nine future replenishments (once every five years over the fifty year planning horizon) of 459,000 cubic meters (600,400 cubic yards). Total sand volume requirements for Alternative 1 equals 5,276,600 cubic meters (6,901,500 cubic yards).

For Alternative 2, total sand volume requirements for both segments combined would consist of initial placement of 937,700 cubic meters (1,226,600 cubic yards) and nine future replenishments (once every five years over the fifty year planning horizon) of 401,800 cubic meters (525,600 cubic yards). Total sand volume requirements for Alternative 1 equals 4,554,000 cubic meters (5,956,500 cubic yards).

4.6.7 Offshore Borrow Sites

SANDAG investigated three potential beach compatible borrow sites near Encinitas and Solana Beaches for their Regional Beach Sand Project, labeled SO-5, offshore of San Dieguito Lagoon, SO-6, offshore of San Elijo Lagoon, and SO-7, offshore of Batiquitos Lagoon (**Figure 4.X**). Another borrow site, Site MB-1, located approximately xx miles south of the project area offshore of Mission Beach, was also identified. Sea Surveyor (1999) collected vibratory core sediment samples at these borrow sites in January 1999. (See Geotechnical Appendix)

The data collected suggested that Site SO-5 contained an estimated 4.74 million cubic meters (6.2 million cubic yards) of suitable beach replenishment material, however, the total available amount of sand will be less if dredging is restricted to depths of 24 meters (80 feet). Site SO-5 is not recommended for the proposed beach fill or hybrid plan alternative, as the sand source at this site is too fine grained.

Before 2001, Site SO-6 contained approximately 1.83 million cubic meters (2.4 million cubic yards) of suitable beach replenishment material. If dredging is limited to water depths of less than 27 meters (90 feet), the total available amount of sand will be reduced to a total of 612,000 cubic meters (800,000 cubic yards). In 2001, SANDAG dredged 78,300 cubic meters (102,400 cubic yards) from site SO-6 to replenish the beach areas located within the Cities of Oceanside, Carlsbad, and Encinitas. This leaves a remaining identified volume of approximately 533,300 cubic meters (697,600 cubic yards) for Site SO-6.

Prior to 2001, Site SO-7 contained a volume of 841,000 cubic meters (1.1 million cubic yards) of suitable beach nourishment material. SANDAG dredged a total of 743,338 cubic meters (972,249 cubic yards) of sand from borrow site SO-7 to replenish the local beaches. This would leave a remaining identified volume of approximately 97,665 cubic meters (127,750 cubic yards) for Site SO-7.

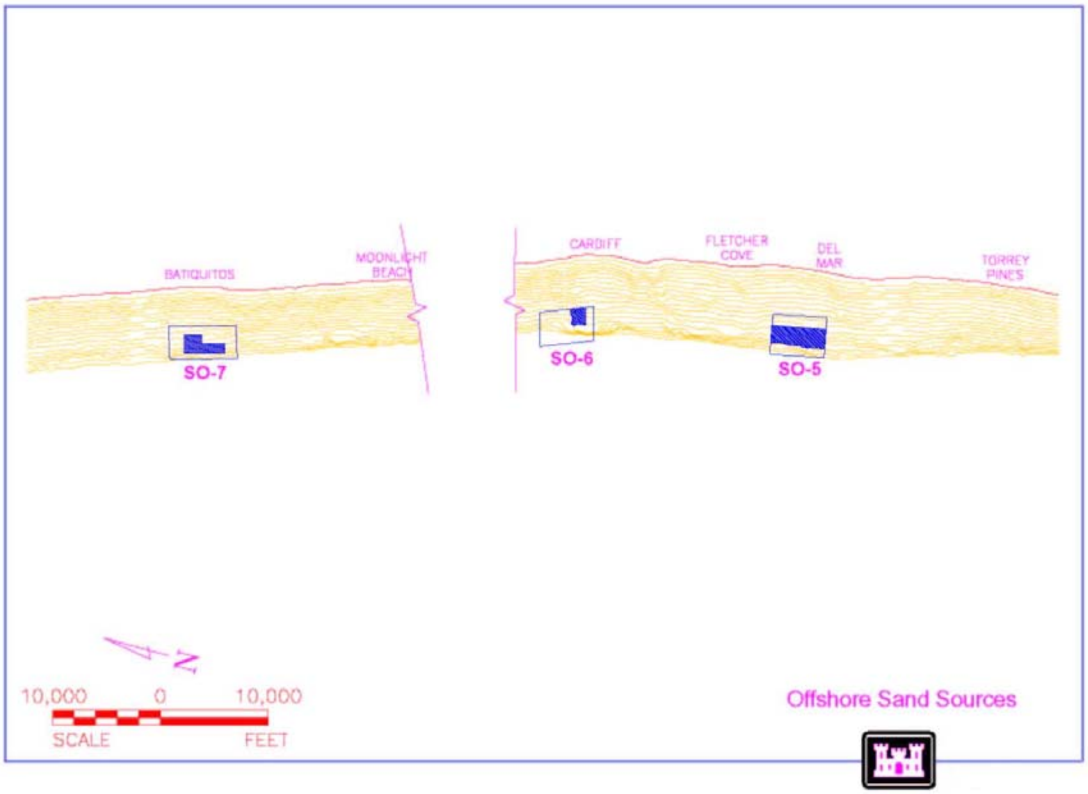
Before 2001, Site MB-1 contained an estimated 19.9 million cubic meters (26 million cubic yards) of suitable beach replenishment material, however, if dredging is limited to water depths of less than 27 meters (90 feet), the total available amount of sand will be reduced to a total of approximately 13.9 cubic meters (18.2 million cubic yards). In 2001, SANDAG dredged an amount of sand from site MB-1 to replenish local beach areas; however, significant reserves of sand remain.

All of the borrow areas are significantly under explored by drilling. The number and spacing of existing borings do not meet USACE guidelines for borrow site characterization. Additional vibratory coring explorations conducted within, and adjacent to, borrow sites SO-6, SO-7, and MB-1, could confirm and expand the known volumes of beach-compatible sand available for dredging.

A program of additional vibratory core borings would possess the potential for significantly increasing the available reserves of suitable beach nourishment sand within the borrow sites.

Results indicate that there is uncertainty regarding the volumes of sand available in the offshore borrow sites, SO-6 and SO-7. Additional explorations of those sites could confirm and expand the known volumes of sand. MB-1, while a greater distance from the project area, contains ample sand volume to accommodate the needs of the project over the entire lifecycle.

FIGURE 4.14- LOCAL OFFSHORE SAND SOURCES



Construction Methods

The sand from the offshore or onshore borrow sites can be transported and placed on the beach mechanically or hydraulically. Hydraulic methods have been used in most of the beach fill projects in the United States. Typically, the sand is lifted from the offshore borrow site by a hydraulic dredge, and is pumped via floating pipelines to the fill site where it is discharged onto the beach. The SANDAG regional sand project conducted in 2001 is a good example of this application (Noble Consultants, 2001). The SANDAG project involved restoration of 12 beaches in San Diego County between Oceanside and Imperial Beach, California. Two million cubic yards of sand were dredged from six offshore borrow sites, transported to each of the 12 beach sites, and carefully placed within the designated beach limits.

It is most likely that beach fills would be constructed using hopper dredge equipment to dredge and transport sand from identified offshore borrow sites located in the San Diego region. A cutter dredge with a booster pump to conduct the beach fill operation may be economically feasible if the distance between the offshore source locations and the receiver sites is within the 4.5-kilometer range.

For a hopper dredge operation, sand is pumped ashore from the dredge, using onboard pumps, through a temporary mooring buoy located about 760 to 1,520 meters (2,500 to 5,000 feet) outside the surf zone at a depth approximately -8 meters, MLLW (-25 feet, MLLW). Conventional earth moving equipment such as bulldozer and front-end loader would build a temporary "L" shaped berm to direct the pumped slurry for settling in a designated area and finally grade the berm profile. The temporary berm is built on a section-by-section basis with an average length of 60 meters (200 feet). The beach-fill operation is likely to be a 24-hour operation that is divided into three manpower shifts. The daily production rate depends on the size of individual hopper dredge and the distance between the offshore borrow site and a receiver beach. As an example, the average load of the hopper dredge used for the SANDAG project ranges approximately from 1,529 to 1,911 cubic meters (2,000 to 2,500 cy), and the average daily production rate is about 9,940 cubic meters (13,000 cy).

Construction Costs

Construction costs for the initial beach fill and each replenishment cycle are presented below. **Table 4-8** shows the breakdown details for each itemized cost. The unit cost assumes the material would be dredged from the offshore borrow site SO-6. A 25% cost contingency has been applied to the unit cost and mobilization/demobilization cost to account for the uncertainty of the sand volumes in SO-6. The contingency would account for the added costs, if required of transporting material from MB-1 for part of the initial placement and/or each renourishment cycle.

The project costs include Construction First Costs and all future costs. Future costs include Net Present Value (NPV) costs for each renourishment cycle, beach profile monitoring, and environmental monitoring.

Project beach monitoring will include bathymetric and topographic surveys every three years, together with a nearly continuous record of the beach topography obtained from the video-based stereo photogrammetric Argus Beach Measurement System. The monitoring period will be for the 50-year period of Federal involvement. The main purpose of project performance monitoring is to allow better planning of continuing construction (periodic renourishment), both in terms of the timing of the renourishment and details of the beach fill construction.

Environmental monitoring will be performed during initial construction, twice during the first year the project is in place (spring, fall), and once annually during the following 4 years (spring), to monitor the environmental effects of the project over one complete renourishment cycle. After the first renourishment cycle, environmental monitoring is expected to occur only during each subsequent renourishment episode. The environmental monitoring will consist of side scan sonar surveys in the nearshore of the project area and within each borrow site used for construction.

Table 4-8 Project Cost for Beach Fill -Alternative 1

Encinitas/Solana Beach Shoreline Feasibility Study Alternative 1 Economic Costs		
Description	Code of Acct.	Alternative 1-Beachfill
1 Dredging		
Segment 1 Dredge Volume(cu. m)		732,800
Unit Cost		$7.03
Segment 2 Dredge Volume (cu. m)		412,800
Unit Cost		$6.75
Subtotal		$7,937,984
Mob/Demob		$1,430,560
Subtotal Dredge Cost		$9,368,544
Contingency 25%		$2,342,136
Total Construction Cost		$11,710,680
PED		$2,000,000
Construction Mgmt (S&A) 7%		$761,194
First Cost Initial Construction		**$14,471,874**
IDC		$159,000
NPV Future Monitoring Cost		$833,385
NPV Future Dredging		$15,114,101
NPV Future Env. Monitoring Cost		$365,117
Gross Investment		**$30,943,478**
Subtotal Annual Cost		$1,794,100
Annual O&M		$25,000
Total Annual Cost		**$1,819,100**

Figure 4-15, below, shows a schematic of the Hybrid Plan.

FIGURE 4-15 HYBRID PLAN SCHEMATIC

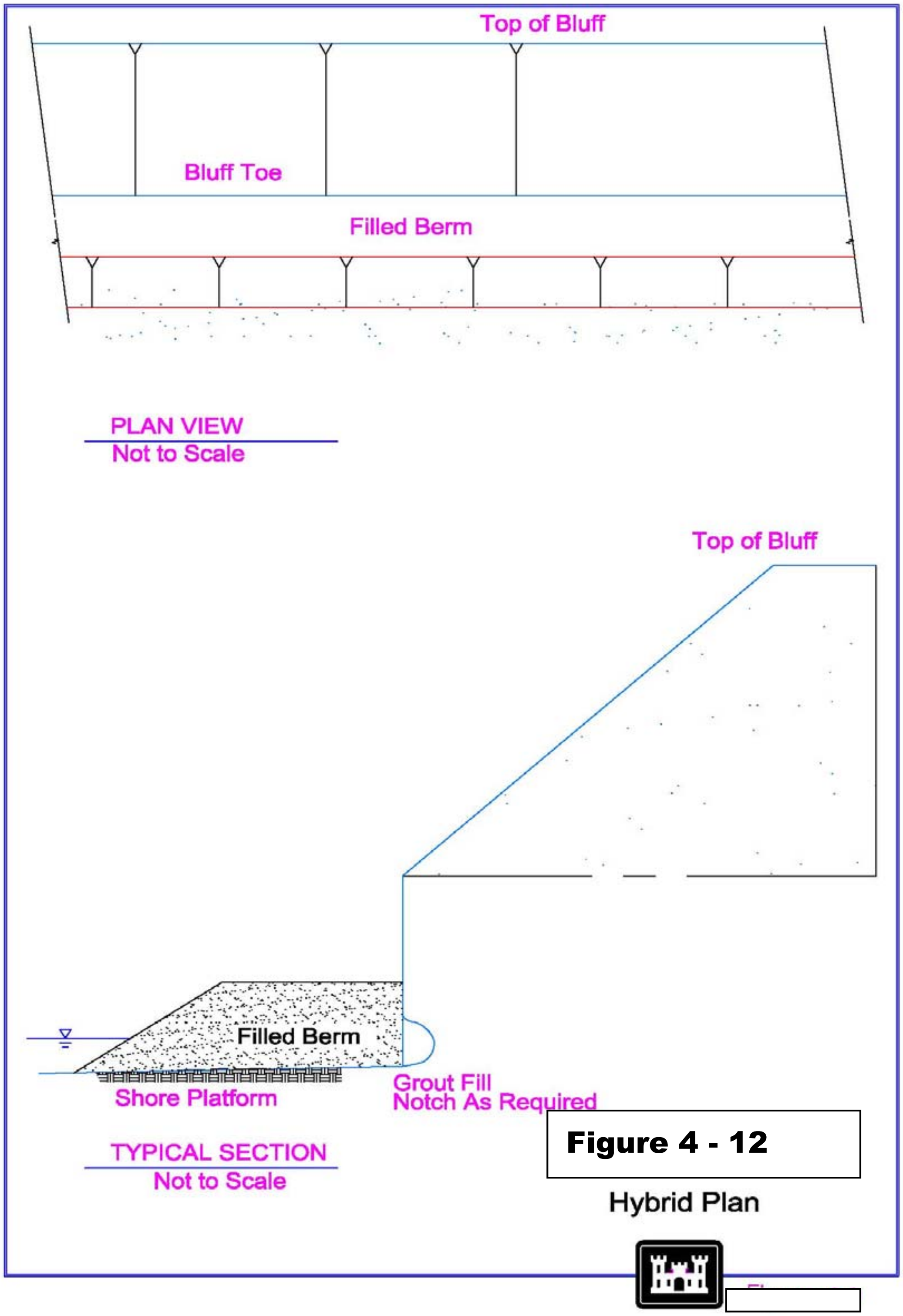


Table 4-9, below, shows the costs, including 25% contingency, for Alternative 2. More detailed costs are available in the Cost Estimating Appendix.

TABLE 4-9 PROJECT COSTS – HYBRID (ALTERNATIVE 2)

Encinitas/Solana Beach Shoreline Feasibility Study Recommended Plan Economic Costs		
Description	Code of Acct.	Alternative 2-Hybrid
1 Dredging		
Segment 1 Dredge Volume(cu. m)		628,100
Unit Cost		$7.03
Segment 2 Dredge Volume (cu. m)		309,600
Unit Cost		$6.75
Subtotal		$6,505,343
Mob/Demob		$1,430,560
Subtotal Dredge Cost		$7,935,903
2 Notch fill (LM)		
Segment 1 length (m)		2,400
Segment 2 length (m)		2,200
Segment 1 Unit Cost (LM)		$318
Segment 2 Unit Cost (LM)		$317
Subtotal Notch fill Cost		$1,459,874
Subtotal Dredge + Notch fill		$9,395,777
Contingency 25%		$2,348,944
Total Construction Cost		$11,744,721
PED		$2,000,000
Construction Mgmt (S&A) 7%		$763,407
First Cost Initial Construction		**$14,508,128**
IDC		$138,000
NPV Future Monitoring Cost		$833,385
NPV Future Dredging		$14,297,322
NPV Future Env. Monitoring Cost		$365,117
Gross Investment		**$30,141,953**
Subtotal Annual Cost		$1,747,600
Annual O&M		$25,000
Total Annual Cost		**$1,772,600**

4.6.8 Alternative 3 - Seawall

Because of construction access limitations and site constraints, seawalls that have been constructed in the study area to protect bluffs against wave attack are limited to either tie-back shotcrete or poured-in-place walls, depending on the required height of the seawall structure.

In Encinitas, seawalls installed in the 1980's are 9.1 to 12.2 meters (30 to 40 feet) in height above the MLLW line. However, cast-in-place walls constructed since 1996 have a top elevation at about +4.9 meters, MLLW (+15 to 16 feet, MLLW) only. Although wave overtopping can still occur under an extreme storm condition, the overtopping storm water appears to induce insignificant abrasion to the Torrey Sandstone bluff face. Thus, the existing low seawalls indeed provide an adequate protection to the bluff base. Therefore, the proposed seawall alternative applicable to Reaches 3, 4 and 5 would be similar to the recently constructed walls. The proposed seawall plan consists of a continuous cast in-place wall panel that is 61 centimeters (24 inches) thick on the bottom and is gradually reduced to 45 centimeters (18 inches) on the top. The wall panel is embedded 61 centimeters (2 feet) into bedrock and is anchored deep into the bluff with tie-back rods. The face of the seawall will be colored and textured to match the surrounding bluff face.

In Solana Beach, a continuous shotcrete wall with a top elevation at +12.2 meters (+40 feet), MLLW and with tie-back anchors embedded deep into the bluff is proposed for Reaches 8 and 9. This is due to the geological formation of a 3-meter (10-foot) thick sand layer beginning at an elevation of approximately +7.6 meters (+25 feet), MLLW, requiring higher stabilization structures to protect it. The thickness of the shotcrete wall is 75 centimeters (30 inches) on the bottom, gradually tapered off to 45 centimeters (18 inches) and embedded 0.6 meter (2 feet) into the bedrock layer. The face of the seawall will be colored and textured to match the surrounding bluff face.

Figure 4-16 shows the cross section view of the wall in Segment One and **Figure 4-17** shows a typical section for Segment Two .

Maintenance of seawalls is expected to be required at approximately 10 year intervals, and consists of repair of cracked or spalled concrete and infilling of any eroded pockets. Estimated costs, including contingency, are shown in **Table 4-5**, following the figures.

FIGURE 4-16- CROSS SECTION VIEW OF SEAWALL IN SEGMENT ONE (ENCINITAS)

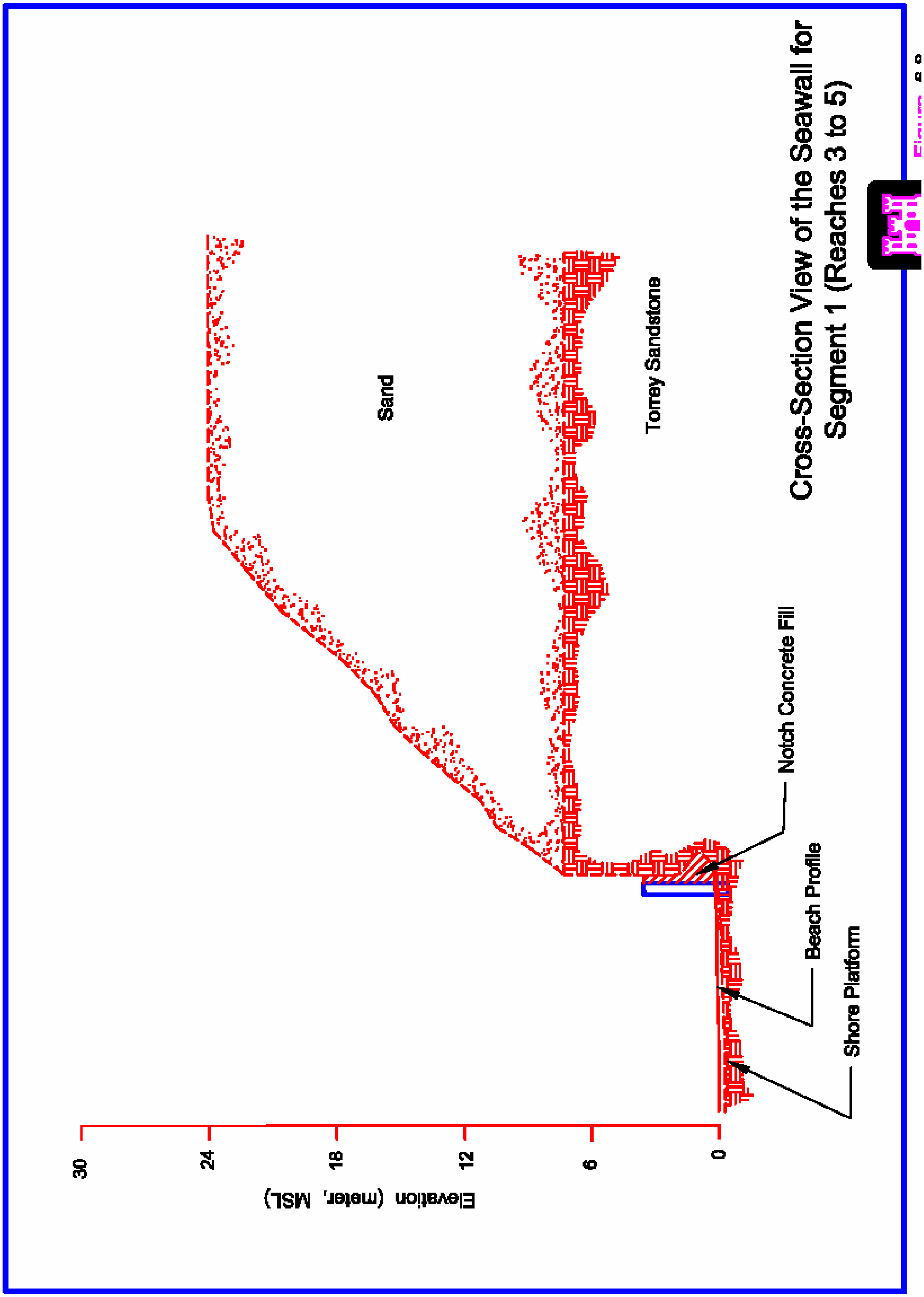


FIGURE 4-17- CROSS SECTION VIEW OF SEAWALL IN SEGMENT TWO (SOLANA)

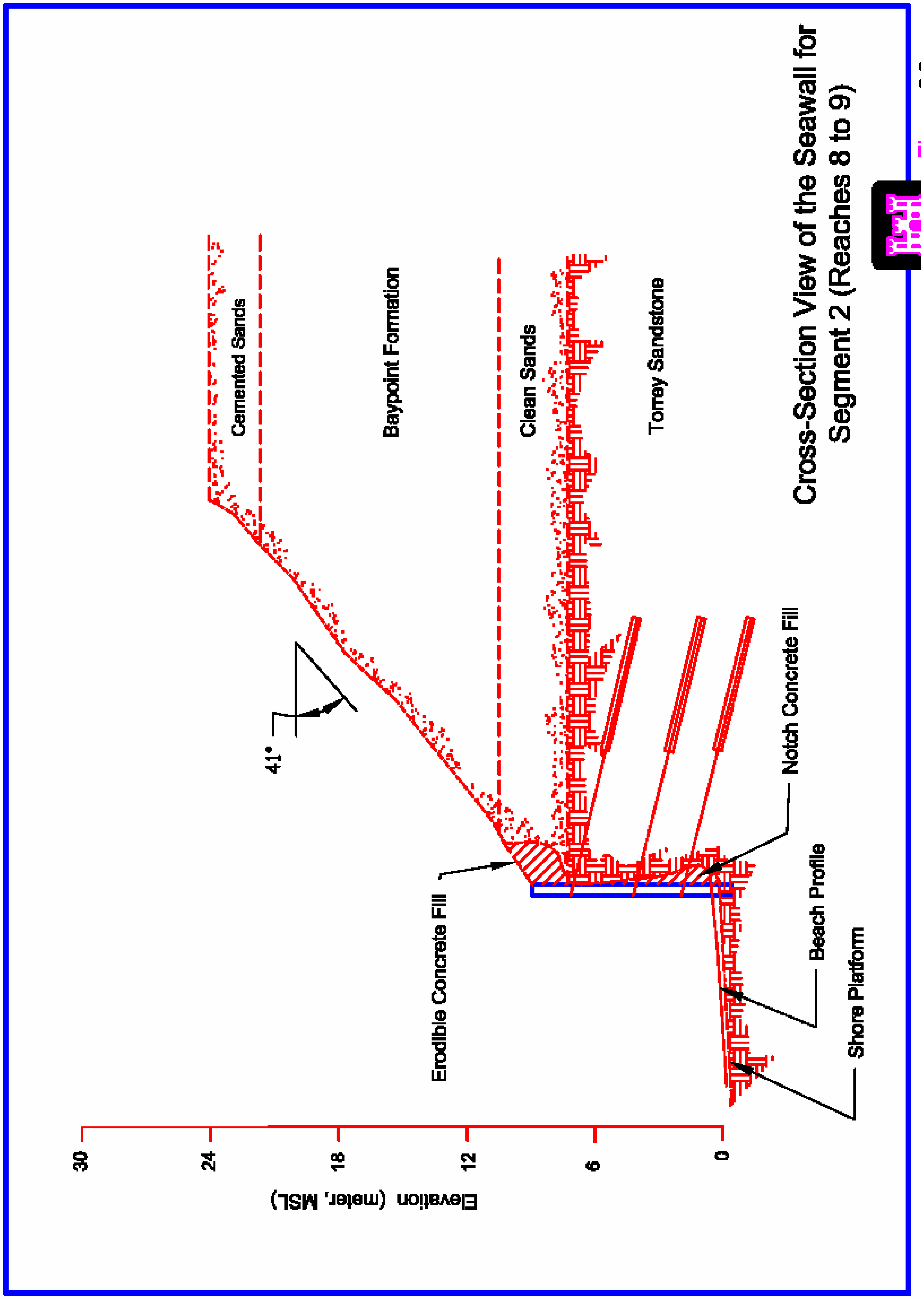


TABLE 4-10 PROJECT COSTS – SEAWALL ALTERNATIVE

Encinitas/Solana Beach Shoreline Feasibility Study Seawall Alternative Economic Costs		
Description	Code of Acct.	Alternative 2-Hybrid
3 Seawall		
Segment 1 (LM)		
Reinforced Concrete wall (LM)		1,790
Unit Cost (LM)		$7,345
Notch Fill (LM)		
Segment 1 Length (m)		2,400
Unit Cost (LM)		$315
Subtotal Segment 1		$13,904,565
Segment 2 (LM)		
Reinforced Concrete wall (LM)		1,400
Unit Cost (LM)		$13,835
Notch Fill (LM)		
Segment 1 Length (m)		2,200
Unit Cost (LM)		$315
Subtotal Segment 2		$20,062,486
Subtotal Seawall Cost		$33,967,051
Contingency 25%		$8,491,763
Total Construction Cost		$42,458,814
PED		$4,245,881
Construction Mgmt (S&A) 7%		$2,759,823
First Cost Initial Construction		**$49,464,518**
IDC		$1,206,000
Gross Investment		**$50,670,518**
Subtotal Annual Cost		$2,937,900
Annual O&M		$97,600
Total Annual Cost		$3,035,500

4.7 COMPARISON OF ALTERNATIVES

Current Corps policy describes the Recommended Plan or National Economic Development (NED) Plan as the plan that has a benefit-to-cost ration greater than 1; maximizes net benefits; and where two cost-effective plans produce no significantly different levels of net benefits, the less costly plan is to be the NED plan even though the level of outputs may be less.

The following tables summarize the major features of the four Alternatives and their Annualized Costs, including periodic nourishment. The four Alternatives are then compared by the system of accounts described above. **Table 4-11**, below, summarizes the major features and quantities, and **Table 4-12** summarizes the costs for the four alternatives.

TABLE 4-11 COMPARISON OF ALTERNATIVE PLAN FEATURES

	ALTERNATIVE FEATURES			
SEGMENT ONE	**ALTERNATIVE #**			
	No Action	Beach Only	Hybrid	Seawall
Characteristic	ALT. 0	ALT. 1	ALT. 2	ALT. 3
Sand - Initial Vol. (cu.m.)	n/a	732,800	628,100	n/a
Sand - Renourish (cu.m.)	n/a	288,300	261,500	n/a
Design Beach Width	n/a	70m	60m	n/a
Design Beach Length	n/a	2,400m	2,400m	n/a
Linear. Notch Fill	n/a	n/a	2,400m	2,400m
Linear Seawall	n/a	n/a	n/a	1,790m
SEGMENT TWO	**ALTERNATIVE #**			
	No Action	Beach Only	Hybrid	Seawall
Characteristic	ALT. 0	ALT. 1	ALT. 2	ALT. 3
Initial Vol. (cu.m.)	n/a	412,800	309,600	n/a
Renourish (cu.m.)	n/a	170,700	140,300	n/a
Design Beach Width	n/a	40m	30m	n/a
Design Beach Length	n/a	2,200m	2,200m.	n/a
Notch Fill Length	n/a	n/a	2,200m	2,200m
Seawall Length	n/a	n/a	n/a	1,400m

TABLE 4-12 COMPARISON OF ALTERNATIVE PLAN ECONOMIC COSTS

Encinitas/Solana Beach Shoreline Feasibility Study
Alternative Cost estimates

Description	Code of	Alternative 1-	Alternative 2-	Alternative 3-
1 Dredging				
Segment 1 Dredge Volume(cu. m)		732,800	628,100	
Unit Cost		$7.03	$7.03	
Segment 2 Dredge Volume (cu. m)		412,800	309,600	
Unit Cost		$6.75	$6.75	
Subtotal		$7,937,984	$6,505,343	
Mob/Demob		$1,430,560	$1,430,560	
Subtotal Dredge Cost		$9,368,544	$7,935,903	
2 Notch fill (LM)				
Segment 1 length (m)			2,400	
Segment 2 length (m)			2,200	
Segment 1 Unit Cost (LM)			$318	
Segment 2 Unit Cost (LM)			$317	
Subtotal Notch fill Cost			$1,459,874	
Subtotal Dredge + Notch fill			$9,395,777	
3 Seawall				
Segment 1 (LM)				
Reinforced Concrete wall (LM)				1,790
Unit Cost (LM)				7,345
Notch Fill (LM)				
Segment 1 Length (LM)				2,400
Unit Cost (LM)				315
Subtotal Segment 1				13,904,565
Segment 2 (LM)				
Reinforced Concrete wall (LM)				1,400
Unit Cost/ (LM)				13,835
Notch Fill (LM)				
Segment 1 Length (LM)				2,200
Unit Cost (LM)				315
Subtotal Segment 2				20,062,486
Subtotal Seawall Cost				33,967,051
Contingency 25%		$2,342,136	$2,348,944	$8,491,763
Total Construction Cost		$11,710,680	$11,744,721	$42,458,814
PED		$2,000,000	$2,000,000	$4,245,881
Construction Mgmt (S&A) 7%		$761,194	$763,407	$2,759,823
First Cost Initial Construction		**$14,471,874**	**$14,508,128**	**$49,464,518**
IDC		$159,000	$138,000	$1,206,000
NPV Future Monitoring Cost		$833,385	$833,385	
NPV Future Dredging		$15,114,101	$14,297,322	
NPV Future Environmental Monitoring Cost		$365,117	$365,117	
Gross Investment		**$30,943,478**	**$30,141,953**	**$50,670,518**
Subtotal Annual Cost		$1,794,100	$1,747,600	$2,937,900
Annual O&M		$25,000	$25,000	$97,600
Total Annual Cost		$1,819,100	$1,772,600	$3,035,500

4.7.1 EQ Acount

The Environmental Quality (EQ) Account is another means of evaluating the alternatives. The EQ Account is intended to display long-term effects that the alternatives may have on significant environmental resources. Significant environmental resources are defined by the Water Resources Council as those components of the ecological, cultural and aesthetic environments, which, if affected by an alternative, could have a material bearing on the decision-making process.

The potential impacts identified below, for the beach replenishment alternatives were based on the Recommended Plan for this study and an analysis of impacts completed for the San Diego Regional Beach Sand Project (SANDAG 2000). In that analysis, SANDAG determined that no long-term significant impacts are expected to occur from a 60-m wide sand placement given the approved monitoring and mitigation program. To date, that monitoring program has not found any significant long-term impacts due to sand placement.

4.8 COMPARISON OF POTENTIAL IMPACTS

The potential impacts identified below for the beach replenishment alternatives were drawn from an analysis of impacts completed for the San Diego Regional Beach Sand Project (SANDAG 2000). In that analysis, SANDAG determined that no long-term significant impacts are expected to occur from a 60-m wide sand placement given the approved monitoring and mitigation program. To date, that monitoring program has not found that significant long-term impacts occurred due to sand placement.

4.8.1 Summary of Potential Environmental Consequences

Table 4-13.
Summary of potential environmental consequences.

Alternative 1 Beach Nourishment	**Alternative 2 Beach Nourishment with Notch Fills**	**Alternative 3 Seawalls with Notch Fills**	**No Action Future Without Project**
TOPOGRAPHY AND GEOLOGY			
Initial placement of beach fill is not expected to result in long-term significant impacts on topography and geology. To maintain adequate shore protection additional sand replenishment is required every 3- 5 years for the life of the project. This is not expected to result in long-term significant impacts to the topography and geology. No significant topography and geology impacts are anticipated to occur to the dredge borrow sites with implementation of Alternative 1. Impacts from renourishment activities are expected to be similar as stated above.	Target width under this alternative would be reduced. Impacts would be similar for those described for Alternative 1 for the beach fill component and renourishment. Additional toe protection would be provided by filling notches that threaten bluff stability. Under this alternative, there is a delay of bluff erosion due to the notch fills. This is not expected to result in long-term significant impacts to the topography and geology. The same borrow sites as Alternative 1 would be used under this alternative but at smaller quantities. No geological impacts are expected at the borrow sites.	The seawalls would reduce bluff erosion for a period of time of at least 50 years, with maintenance. This is not expected to result in long-term significant impacts to the topography and geology.	No significant impacts would occur to topography and geology; however, the receiver beaches and bluffs would continue to erode undeterred and the project benefits would not occur.

Table 4-13.
Summary of potential environmental consequences.

Alternative 1 Beach Nourishment	Alternative 2 Beach Nourishment with Notch Fills	Alternative 3 Seawalls with Notch Fills	No Action Future Without Project
OCEANOGRAPHY AND COASTAL	**PROCESSES**		
Initial placement of beach fill is not expected to result in long-term significant impacts on oceanographic and coastal processes. To maintain adequate shore protection additional sand replenishment is required every 3- 5 years for the life of the project. This is not expected to result in long-term significant impacts to the oceanographic and coastal processes. No significant oceanographic impacts are anticipated to occur to the dredge borrow sites with implementation of Alternative 1. Impacts from renourishment activities are expected to be similar as stated above.	Target width under this alternative would be reduced. Impacts would be similar for those described for Alternative 1 for the beach fill component and renourishment. Additional toe protection would be provided by filling notches that threaten bluff stability. Under this alternative, there is a delay of bluff erosion due to the notch fills. This is not expected to result in long-term significant impacts to the oceanographic and coastal processes. The same borrow sites, as Alternative 1 would be used under this alternative but at smaller quantities. Impacts from renourishment activities are expected to be similar as stated above.	The seawalls would reduce bluff erosion for a period of time of at least 50 years, with maintenance. This is not expected to result in long-term significant impacts to the oceanographic and coastal processes.	No significant impacts would occur to oceanographic and coastal processes; however, the receiver beaches and bluffs would continue to erode undeterred and the project benefits would not occur.
WATER AND SEDIMENT QUALITY			
None of the fill material would exceed the criteria established in the California Ocean Plan for bacteria, dissolved oxygen, contaminants and sulfides, nutrients, or pH and there would be no significant impacts associated with placement of fill material at the receiver sites. Turbidity associated with construction is expected to be short term and localized. Impacts as a result of turbidity are not expected to result in long-term significant impacts on water quality. Dredging at the borrow sites would not result in significant	Impacts would be similar for those described for Alternative 1 for the beach fill component. Impacts would be similar for those described for Alternative 1 for the dredging component. The same borrow sites would be used under this alternative but at smaller quantities. Additional toe protection would be provided by filling notches that threaten bluff stability. Notch fill construction activities are not expected to have adverse water quality or sediment impacts.	Seawall and notch fill construction activities are not expected to have adverse water quality or sediment mpacts.	As no dredging or replenishment activities are proposed under this alternative. No change to water quality or sediments would result.

Table 4-13.
Summary of potential environmental consequences.

Alternative 1 Beach Nourishment	Alternative 2 Beach Nourishment with Notch Fills	Alternative 3 Seawalls with Notch Fills	No Action Future Without Project
impacts to water quality at any of the borrow sites. Impacts from renourishment activities are expected to be similar as stated above.	Impacts from renourishment activities are expected to be similar as stated above.		
BIOLOGICAL RESOURCES			
Direct impacts to surfgrass, reefs, kelp, and other resources will be avoided during placement of the sand material and no direct impacts are anticipated. Indirect impacts to these resources from longshore transport of fill material are not expected. Initial fill material will bury the existing benthic community. Due to rapid recolonization of benthic communities, impacts are expected to be short term and insignificant. Placement methods and monitoring would ensure that there would be no significant impacts to spawning grunion or grunion eggs during construction and renourishment. No significant indirect impacts to biological resources are expected due to turbidity. Impacts associated with placement of fill material to shorebird foraging will be temporary and insignificant. No significant impacts to fish species is likely to occur. No impacts to marine mammals and threatened and endangered species are expected. Impacts to EFH are expected to be minor and insignificant. Impacts from renourishment activities are expected to be similar as stated above.	Impacts associated with beach fill activities and renourishment would be similar for those described for Alternative 1. The same borrow sites would be used under this alternative but at reduced quantities. Notch fill construction activities are not expected to have adverse impacts on-site biological resources.	Seawall and notch fill construction and maintenance activities are not expect to have adverse impacts to biological resources.	No change to onshore, nearshore or offshore biological resources would occur. There would be no opportunity to improve shore bird and grunion habitat in currently cobble beaches.
CULTURAL RESOURCES			
There are no known cultural resources in the Area of Potential Effects (APE). No significant impacts are anticipated from construction	There are no known cultural resources in the APE. No significant impacts are anticipated from construction, renourishment, or	There are no known cultural resources in the APE. No significant impacts are anticipated from	Significant impacts to cultural resources would occur if these resources are present on a bluff that collapses due to a lack of

Table 4-13.
Summary of potential environmental consequences.

Alternative 1 Beach Nourishment	Alternative 2 Beach Nourishment with Notch Fills	Alternative 3 Seawalls with Notch Fills	No Action Future Without Project
or renourishment activities.	maintenance activities.	construction or maintenance activities.	protection.
AESTHETICS			
Construction impacts would be short term and insignificant. Long-term impacts from a wider beach are expected to have beneficial impacts. The borrow sites are located far off shore; therefore, potential aesthetic impacts associated with dredging at the borrow sites are insignificant. Impacts from renourishment activities are expected to be similar as stated above.	Impacts would be similar for those described for Alternative 1 for the dredging and renourishment component. Impact from the construction of the notch fills are short term and insignificant.	Significant impacts to aesthetics due to the presence of the seawall are expected to occur.	Under the No Action Alternative, the beaches would not be enhanced nor would bluff erosion be alleviated. Where there are visible cobbles they would remain and where the beach overall is narrow it would not be widened. Adjacent residents and beach users would not experience disturbance during construction or views of the pipeline; however, they would not experience the benefits of more scenic beaches.
AIR QUALITY			
The sand would be moist and the potential for dust generation would be very low; impacts would be less than significant. Emissions of CO, ROC, SOx and NOx from dredge and construction equipment are expected to be significant. Impacts from renourishment activities are expected to be significant.	Impacts from beach replenishment and renourishment would be similar for those described for Alternative 1 and are expected to be significant. The notch fills construction is not expected to have any significant impacts to air quality.	Seawalls construction is not expected to have any significant impacts to air quality.	As no construction would occur, no air quality impacts would result.
NOISE			
Noise from dredging and placement of fill material activities would be indistinguishable from background. No impacts are expected. Grading on the beach during the day is not expected to exceed local noise ordinance limits. Impacts will be considered insignificant. Nighttime and weekend work at receiver beaches would exceed local ordinance limits and be performed under variance. Residents of homes near the receiver sites would be notified prior to the work, and adverse nighttime noise	Impacts from beach replenishment and renourishment would be similar for those described for Alternative 1, however beach replenishment would take less time thus reducing noise impacts. Notch fill construction activities are not expected to have adverse noise impacts.	Construction of seawalls on the beach during the day is not expected to exceed local noise ordinance limits. Impacts will be considered insignificant. Nighttime and weekend construction activities on beaches would exceed local ordinance limits and be performed under variance.	There would be no change to current noise levels.

Table 4-13.
Summary of potential environmental consequences.

Alternative 1 Beach Nourishment	Alternative 2 Beach Nourishment with Notch Fills	Alternative 3 Seawalls with Notch Fills	No Action Future Without Project
events would occur for no more than three consecutive days within 200 ft of individual homes. Nighttime noise impacts would be short term and insignificant. Impacts from renourishment activities are expected to be similar as stated above.			
SOCIOECONOMICS			
There would be no significant direct impacts to the commercial and recreational fishery as a result of dredging. Impacts to kelp harvesting activities are expected to be insignificant. Beach fills will be conducted so as to not result in major beach closures. Recreational opportunities would not be significantly reduced and thus recreational economic impacts are insignificant. Impacts from renourishment activities are expected to be similar as stated above.	Impacts would be similar for those described for Alternative 1 for beach placement and dredging. The beach width would be smaller which will reduce the amount of time spent overall on dredging and placement activities. The notch fills construction activities are not expected to have adverse socioeconomic impacts. Impacts from renourishment activities are expected to be similar as stated for Alternative 1.	The seawall construction activities are not expected to have any socioeconomic impacts	There would be no change to current commercial or sport fisheries fluctuations.
TRANSPORTATION			
No significant impacts are expected from this alternative, however local residents may experience a minor short-term increase in traffic. Impacts from renourishment activities are expected to be similar as stated above.	No significant impacts are expected from this alternative, however local residents may experience a minor short-term increase in traffic Impacts from renourishment activities are expected to be similar as stated above.	No significant impacts are expected from this alternative, however local residents may experience a minor short-term increase in traffic congestion.	As no beach replenishment or toe stabilization activities would occur, no trips would be generated.
LAND USE			
No significant impacts are expected due to construction activities. Existing land uses will be enhanced due to the anticipated protection of the bluff and resultant reduction in loss of property. Recreational areas will be enhanced. Impacts from renourishment activities are expected to be similar as stated above.	Impacts from beach replenishment and renourishment would be similar for those described for Alternative1. Construction of notch fill is not expected to have any impacts to land use.	Construction of seawalls is not expected to have any impacts to land use.	There would be a loss of land use and impacts to recreation under this alternative as a result of bluff failures.
RECREATION			

Table 4-13.
Summary of potential environmental consequences.

Alternative 1 Beach Nourishment	Alternative 2 Beach Nourishment with Notch Fills	Alternative 3 Seawalls with Notch Fills	No Action Future Without Project
Beach fills will be conducted so as to not result in major beach closures. Recreational opportunities would not be significantly reduced. Recreational impacts are expected to be insignificant. Impacts from renourishment activities are expected to be similar as stated above.	Impacts from beach replenishment and renourishment would be similar for those described for Alternative1. Construction of notch fills is not expected to have any impacts to recreation.	Construction of seawalls is not expected to have any impacts to recreation.	No recreational benefits would occur since no sand would be replenished on the beaches within the study area.
PUBLIC SAFETY			
During beach replenishment operations, safety measures would be implemented in the vicinity of the receiver beaches, including fencing, barricades, and flag personnel, as necessary. Asscess for emergency personnel to the beach and to the water wll be maintained. Impacts to public safety are expected to be insignificant. Impacts from renourishment activities are expected to be similar as stated above.	Public safety impacts under this alternative would be similar to those described for Alternative 1. Construction of notch fills is not expected to have any impacts to public safety.	Construction of seawalls and notch fills is not expected to have any impacts to public safety.	No dredging or replenishment or toe stabilization activities would occur. At some receiver beaches, waves would continue to erode fragile bluffs that support property and structures. This erosion would continue unabated and may lead to significant impacts to health and safety as bluffs continue to erode and collapse. There have been four fatalities caused by collapsing bluffs in San Diego County in the last several years.
PUBLIC UTILITIES			
Public utilities located in or near the sand placement locations will be avoided and coordination with local utility companies will occur. No significant impact to public utilities is expected. Impacts from renourishment activities are expected to be similar as stated above.	Impacts from beach replenishment and renourishmentwould be similar for those described for Alternative 1. Construction of notch fills is not expected to have any impacts to public utilities.	Construction of seawalls is not expected to have any impacts to public utilities.	The beneficial effect of stabilizing structures such as stairways and outfalls would not occur under this alternative. Impacts to public utilities may result as a result of loss of bluff property.

4.8.2 NED Account

4.8.2.1 Storm Damage Reduction Benefits

All alternatives are expected to provide storm damage reduction through the practical elimination of bluff toe erosion in Reaches 3, 4, 5, 8, and 9. Alternative 1 protects the toe with sand alone, Alternative 2 with a combination of sand and erodible concrete notch fills, and Alternative 3 with hard seawalls. Although there will likely be incidental benefits to Reaches 1, 2, 6, and 7, these benefits did not qualify for inclusion into the NED analysis, as they are small, uncertain, difficult to quantify, and do not affect plan formulation or selection.

4.8.2.2 Residual Damages

Under all three alternatives, wherever bluff toe erosion is stopped, some residual slumping of the upper bluff will occur until the bluff face reaches a stable angle of repose (see Geotechnical Appendix). An estimate of the amount of blufftop land that would be lost during the project life as a result of this "stability slumping" was developed. The value of the land lost each year was converted to present value and then annualized. The table below shows average annual damages and the amount of expected "stability slumping" damages that would occur under all three alternatives, by Segment. **Table 4-5** previously showed the damages by reach for all reaches, including residual damages. Removing residual damages and removing those reaches where no federal project is justified leaves the following adjusted project benefits:

Table 4-14 With Project Average Annual Total Potential Damage Reduction Benefits

Reach	Without Project Damage	With Project "Stability Slumping" Residual Damage	Total Potential Damage Reduction Benefits
3	$164,817	$9,863	$154,954
4	$325,406	$63,440	$261,967
5	$467,081	$25,704	$441,377
8	$375,792	$18,823	$356,968
9	$423,695	$10,647	$413,048
Total	**$1,756,791**	**$128,477**	**$1,628,313**

4.8.2.3 Recreation Benefits

Two proposed alternatives, the beach fill and hybrid plans, would provide additional beach area above that of the without project condition. The optimization process determined the size and the number of replenishment cycles. Based on the optimization process, Alternative 1 (Beach Fill) will include an initial beach of 70 meters and replenishment cycle of 5 years in Segment 1, and initial beach of 40 meters and replenishment cycle of 6 years in Segment 2. For Alternative 2 (the Hybrid Plan), the optimum plan includes an initial beach of 60 meters with a 5 year replenishment cycle for Segment 1, and an initial beach of 30 meters and a 5 year replenishment cycle for Segment 2.

The UDV for the without project condition was measured at 34 throughout the period of analysis. The total net present value of recreation for the project area under the without project condition was estimated at $329,690,000. On an average annual basis this recreational value would equal

$19,116,000. Recreation in the study area can be separated into two distinct areas: reaches 3 thru 5 and reaches 8 & 9 (Segment One and Segment Two). For these areas the without project net present and average annual values are given in **Table 4-15,** below.

Table 4–15 Without Project Recreation Value

Area	NPV	Average Annual
Reaches 3 – 5	$231,865,000	$13,444,000
Reaches 8 & 9	$97,825,000	$5,672,000
Total	$329,690,000	$19,116,000

The additional beach areas of the beach fill and hybrid plans will alter unit day values. Changes in UDV will occur in three of the criteria, these being: recreation experience, carrying capacity, and environmental. A UDV estimate of the plans yields estimates of 57 for beach fill and 54 for the hybrid at their maximum beach widths; see Table 4-16 and Table 4-17.

Table 4-16
Unit Day Value Scores: With Project - Beach Fill alternative

Category	**Segment 1**		**Segment 2**	
	Max	**Min**	**Max**	**Min**
Recreation Experience	10	8	7	6
Availability of Opportunity	3	3	3	3
Carrying Capacity	11	9	9	8
Accessibility	18	18	18	18
Environmental	15	14	13	12
Total Score	57	52	50	47
Unit Day Value	$6.98	$6.69	$6.57	$6.34

Table 4-17
Unit Day Value Scores: With Project - Hybrid Plan

Category	**Segment 1**		**Segment 2**	
	Max	**Min**	**Max**	**Min**
Recreation Experience	10	6	5	5
Availability of Opportunity	3	3	3	3
Carrying Capacity	9	8	8	7
Accessibility	18	18	18	18
Environmental	14	12	11	10
Total Score	54	47	45	43
Unit Day Value	$6.80	$6.34	$6.19	$6.03

Both segments for the Hybrid Plan operate under a 5-year beach restoration process and Beach Fill has segment 1 with a 5-year cycle and segment 2 with a six year cycle. For each of the alternatives a uniform decline is assumed from high to low based on the width of the beach. Applying the same beach attendance projection of the without project condition to these alternatives results in NPV estimates of $432,699,000 and $416,408,000 for beach fill and hybrid, respectively.

Table 4-18 Recreation Benefits With Project

	NPV	Average Annual
Beach Fill		
Reaches 3 – 5	$310,367,000	$17,995,000
Reaches 8 & 9	$122,332,000	$7,093,000
Total	$432,699,000	$25,088,000
Hybrid		
Reaches 3 – 5	$299,554,000	$17,369,000
Reaches 8 & 9	$116,854,000	$6,775,000
Total	$416,408,000	$24,144,000

Table 4-19 Future Participation and Value for the Project Area

	2009	2020	2030	2040	2058
Participation	3,305,093	3,733,854	4,081,585	4,081,585	4,081,585
Without Project	$16,869,195	$19,057,591	$20,832,411	$20,832,411	$20,832,411
Beach Fill	$22,658,173	$25,189,326	$27,535,191	$27,535,191	$26,869,234
Hybrid Plan	$21,876,163	$24,561,794	$26,849,217	$26,849,217	$25,500,156

The net change in recreational value is $103,008,000 for the beach fill alternative and $86,717,000 for the hybrid plan. On an annual basis these recreational gains equate to $5,972,000 for beach fill and $5,027,000 for the hybrid plan.

Maximum Allowable Recreation Benefits

According to the regulatory limit of ER-1105-2-100 recreation benefits used in project NED analysis are capped at the value of storm damage reduction. Therefore, the annual recreational benefits for both the beach fill and hybrid alternatives are capped to equal the storm damage benefit in the NED analysis, with a high degree of certainty this level will be exceeded in practice.

4.8.2.4 Summary of NED Benefits/Costs

The four alternatives under consideration have the following construction and replenishment costs.

Table 4-20 Alternatives Construction & Replenishment Costs

Alternative	Initial Construction Costs	Replenishment Costs (NPV)	Monitoring Costs	Environmental Monitoring Costs	Total
Beach Fill	$14,471,875	$15,114,101	$833,386	$365,117	$30,784,500
Hybrid	$14,508,129	$14,297,322	$833,386	$365,117	$30,004,000
Seawall	$49,834,518	NA	NA		$49,834,500
Revetment	$45,126,132	NA	NA		$45,126,100

The IDC calculations were based upon a simplifying assumption of equal payments over the period of construction, since no detailed projections were developed. For the Beach Fill and Hybrid alternatives each alternative is assumed to have a six month construction period for the initial nourishment of the beaches (includes PED, SA and evaluated with the 5.375% discount rate). The seawall and revetment alternatives are expected to have construction period of one year (includes PED, SA and evaluated with the 5.375% discount rate). Therefore, the NED economic cost of these alternatives is,

Table 4-21 Construction Economic Cost		
Alternative	**IDC Costs**	**Total Costs with IDC**
Beach Fill	$159,000	$30,943,500
Hybrid	$138,000	$30,142,000
Seawall	$1,206,000	$50,670,500
Revetment	$1,101,000	$46,227,100

Total annual costs for the alternatives are,

Table 4-22 Total Annual Costs			
Alternative	**Construction Cost**	**O&M Costs**	**Total Annual Cost**
Beach Fill	$1,794,100	$25,000	$1,819,100
Hybrid	$1,747,600	$25,000	$1,772,600
Seawall	$2,937,900	$97,600	$3,035,500
Revetment	$2,680,300	$75,600	$2,755,900

The benefits for Beach Fill (alternatives 1) and Hybrid Plan (alternative 2) are based on the optimization process described in section 5.2. The benefit analysis for Seawall (alternative 3) assumed that this alternative will be effective in eliminating all the without project damages, except for the natural sloughing of the bluff. The Emergency Protection Benefits represents the reduction in Armoring and Stairways Costs. Benefits for these plans are,

Table 4-23 Total Annual Benefits				
Alternative	**Emergency Protection Benefits**	**Land Loss Benefits**	**Recreation**	**Total Benefits**
Alt 1. Beach Fill	$802,372	$343,874	$1,146,246	$2,292,500
Alt 2. Hybrid	$903,777	$387,334	$1,291,111	$2,582,200
Alt 3. Seawall	$1,139,819	$488,494	$0	$1,628,300

Net NED benefits and B/C ratios are,

Table 4-24 Annual Net NED Benefits & B/C Ratios				
Alternative	**Annual Costs**	**Annual Benefits**	**Net NED Benefits**	**B/C Ratio**
Alt 1. Beach Fill	$1,819,100	$2,292,500	$473,400	1.26
Alt 2. Hybrid	$1,772,600	$2,582,200	$809,600	1.46
Alt 3. Seawall	$3,035,500	$1,628,300	($1,407,200)	0.54

The most important information from the table above is the estimation of the net NED benefits for the respective plans. The plan with the greatest net benefits is, by definition, the NED plan. Importantly, the relative B/C Ratios of the alternatives, while an important indicator of their economic viability, does not play a role in determining the NED plan. The table shows that of the four plans, the Hybrid plan has the greatest net benefits. The annual net benefits of this plan are approximately $809,600. Therefore, the Recommended or NED Plan is Alternative 2, the Hybrid Plan.

6Incremental Analysis of the NED Plan

The NED plan, Hybrid alternative, consists of two distinct and independent features. The two general reach segments, reaches 3 thru 5 and reaches 8 & 9, can each be implemented and function as designed regardless if the other is implemented. Because each operates independently, a further economic analysis is required to verify that each segment on its own is justified.
The first check on the components of the Hybrid alternative is to verify that each component of the Hybrid alternative produces the greatest net NED benefits for that component. For both the Seawall and Revetment alternatives the construction costs for each component part exceed those of the Hybrid alternative. In addition, the hybrid alternative benefits for segment 1 and 2 are significantly higher than the benefits for the Seawall and the Revetment alternatives. Both Seawall and Revetment alternative can be eliminated from the incremental analysis, due to the higher costs and significantly less benefits for each of the segments. Also, segment 1 for the Beach Fill can be eliminated from further considerations, since the annual costs for this segment exceed the Hybrid alternative and the segment has less annual benefits. In segment 2, the beach fill annual costs are slightly less than the Hybrid alternative; however, since the benefits for Hybrid alternative in this segment is $226,000 more than Beach Fill, this segment can be eliminated from the incremental analysis.
Having eliminated the components of the alternatives, the final step is to verify that each component of the Hybrid alternative produces positive net NED benefits on its own. The Hybrid alternative's construction costs by reach segment are:

Table 4-25 Incremental Construction Costs – Hybrid Alternative

Segment	Construction Cost	IDC	Total Cost
Segment 1	$18,644,900	$86,000	$18,730,900
Segment 2	$11,359,000	$52,000	$11,411,000
Total	$30,004,000	$138,000	$30,142,000

Amortizing each segments total cost over 50 years at the current discount rate of 5.375 percent yields annual costs of $1,086,031 for segment 1 and $661,618 for segment 2. Annual O&M costs for these segments are $12,500 for each segment. Total annual costs for these segments are:

Table 4-26 Annual Costs – Incremental Segments of the Hybrid Alternative

Segment	Annual Construction Cost	Annual O&M Cost	Total Annual Cost
Segment 1	$1,086,000	$12,500	$1,098,500
Segment 2	$661,600	$12,500	$674,100
Total	$1,747,600	$25,000	$1,772,600

Storm damage reduction benefits for these segments are shown in Table 6-3. Total NED benefits for these segments are:

Table 4-27 Annual Benefits – Incremental Segments of the Hybrid Alternative

Segment	Emergency Protection Benefits	Land Loss Benefits	Recreation Benefits	Total Benefits
segment 1	$516,645	$221,419	$738,064	$1,476,100
segment 2	$387,132	$165,914	$553,046	$1,106,100
Total	$903,777	$387,333	$1,291,111	$2,582,200

Incremental justification for each of the components of the Hybrid alternative is shown below.

Table 4-28 Hybrid Alternative – Incremental Justification, Annual Net NED Benefits & B/C Ratios

Segment	Annual Costs	Annual Benefits	Net NED Benefits	B/C Ratio
segment 1	$1,098,500	$1,476,100	$377,600	1.34
segment 2	$674,100	$1,106,100	$432,000	1.64

Chapter 5. Recommended Plan

5.1 General

The Recommended or NED Plan is the plan that has a benefit-to-cost ratio greater than one and produces the greatest net benefits. Based on an analysis of the costs and benefits outlined above and documented in the appendices, the Hybrid Plan, Alternative 2, is the Recommended Plan. This alternative produces the highest net benefits with minimal impact on the environment, and is supported by the local sponsors. It achieves almost all of the project objectives for the shoreline (it does not directly address flooding of Reach 7), and is complete, efficient, effective, and acceptable, meeting the four established criteria.

5.2 Recommended Plan Description

The hybrid plan alternative consists of two components: notch fill at the bluff base and sand nourishment on the beach. Figure 5-1 illustrates the Recommended Plan

Notch fill- The construction procedure consists of scraping sand layer away to expose the bedrock layer; and sealing up eroded notches with erodible concrete. The shotcrete gunite with special grout material is typically used for the notch-fill construction as it builds up the concrete seal layer-by-layer and is less impacted by the rising tides. The construction equipment required includes a backhoe for sand scraping and a high-pressured nozzle for concrete fill. In Segment 1, the The notch fill will extend approximately 2.4 km along the toe of the bluff in Segment 1 and approximately 2.2 km in Segment 2 The particular design for a notch fill is based on the geotechnical characteristics of the area and the size of the notch The size and quantity of notch fill will depend on depth and height of notch at each specific location.

Beach fill- In Segment 1, approximately 628,100 cm of beach quality sand would be initially placed along 2.4 km (1.5 mi) of shoreline providing a nourishment width of 60 meters at a berm elevation of approximately +3.9 meters (+12.8 feet) Mean Lower Low Water (MLLW). The berm would be flat and approximately 60 meters wide. The beach fill would then naturally slough seaward approximately 43 meters (134 feet) at a slope of 10:1 (horizontal distance:vertical distance). The beach fill will be tapered into the existing beaches to the north and south of the segment. Beach replenishment of an additional sand volume of 261,500 cm would occur on average every 5 years within the 50-year project lifetime.

In Segment 2, approximately 309,600 cm of beach quality sand would be initially placed along 2.2 km of the shoreline, providing a nourishment width of 30 meters at a berm elevation of approximately +3.9 meters (+12.8 feet) Mean Lower Low Water (MLLW). The berm will be flat and approximately 30 meters wide. The beach fill would then naturally slope seaward approximately 38 meters (119 feet) at a slope of 10:1 (horizontal distance:vertical distance). The beach fill will be tapered into the existing beaches to the north and south of the segment. Beach replenishment of an additional sand volume of 140,300 cm would occur on average every 5 years within the 50-year project lifetime. **Table 5-1** presents a summary of the project costs for the Recommended Plan. **Table 5-2** summarizes the costs and benefits of the Recommended Plan.

Figure 5-1 shows a schematic cross section of the hybrid plan**.** Cross-sections of the Recommended (Hybrid) Plan beach fill in Segment 1 and Segment 2 are shown in red in **Figures 5-2 and 5-3,** below.

Beach profiles and widths for Alternative 1 are also illustrated for comparison. Plan views showing the total area covered by the placement of sand in Segments 1 and 2 are shown on **Figures 5-4** and **5-5**. The red lines represent the seaward limit of the top of the design berm and the seaward limit of the toe of the design berm. **Figures 5-6 and 5-7** below, show a typical notch sea cave formation and a notch fill without beach replenishment.

FIGURE 5-1 RECOMMENDED PLAN TYPICAL CROSS SECTION SCHEMATIC

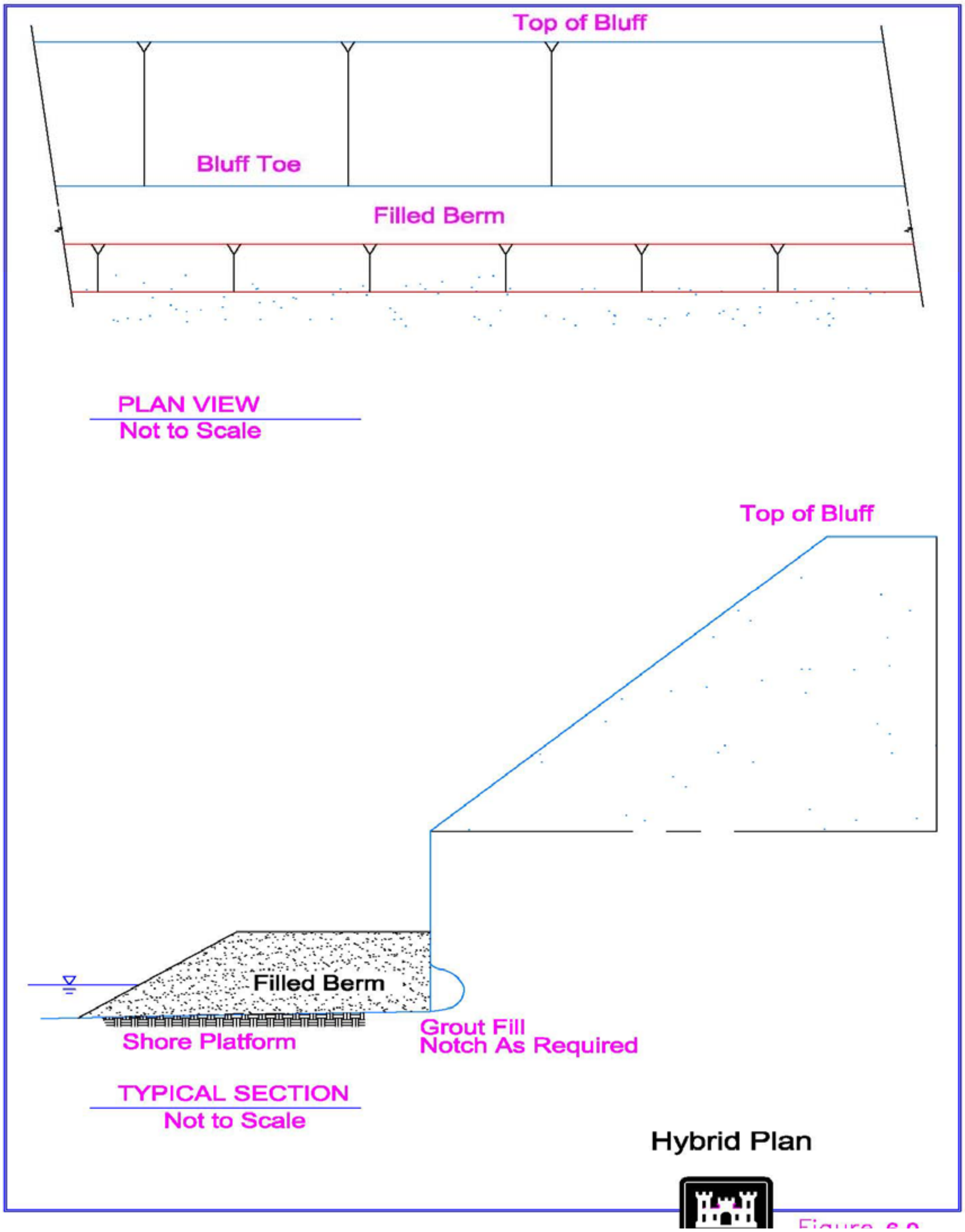


FIGURE 5 – 2   CROSS SECTION BEACH FILL SEGMENT ONE (HYBRID PLAN)

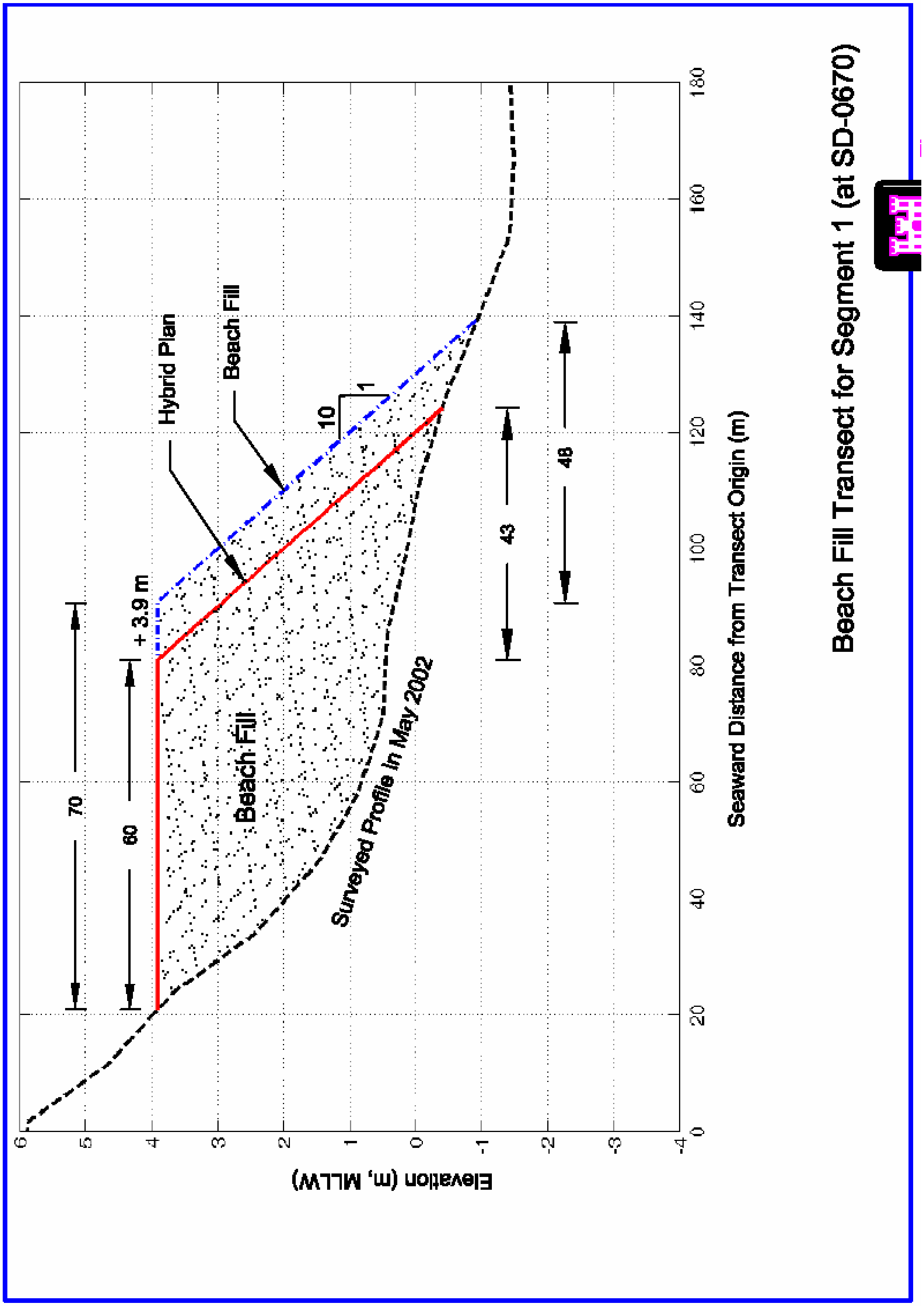


FIGURE 5 –3 –CROSS SECTION BEACH FILL SEGMENT TWO (HYBRID PLAN)

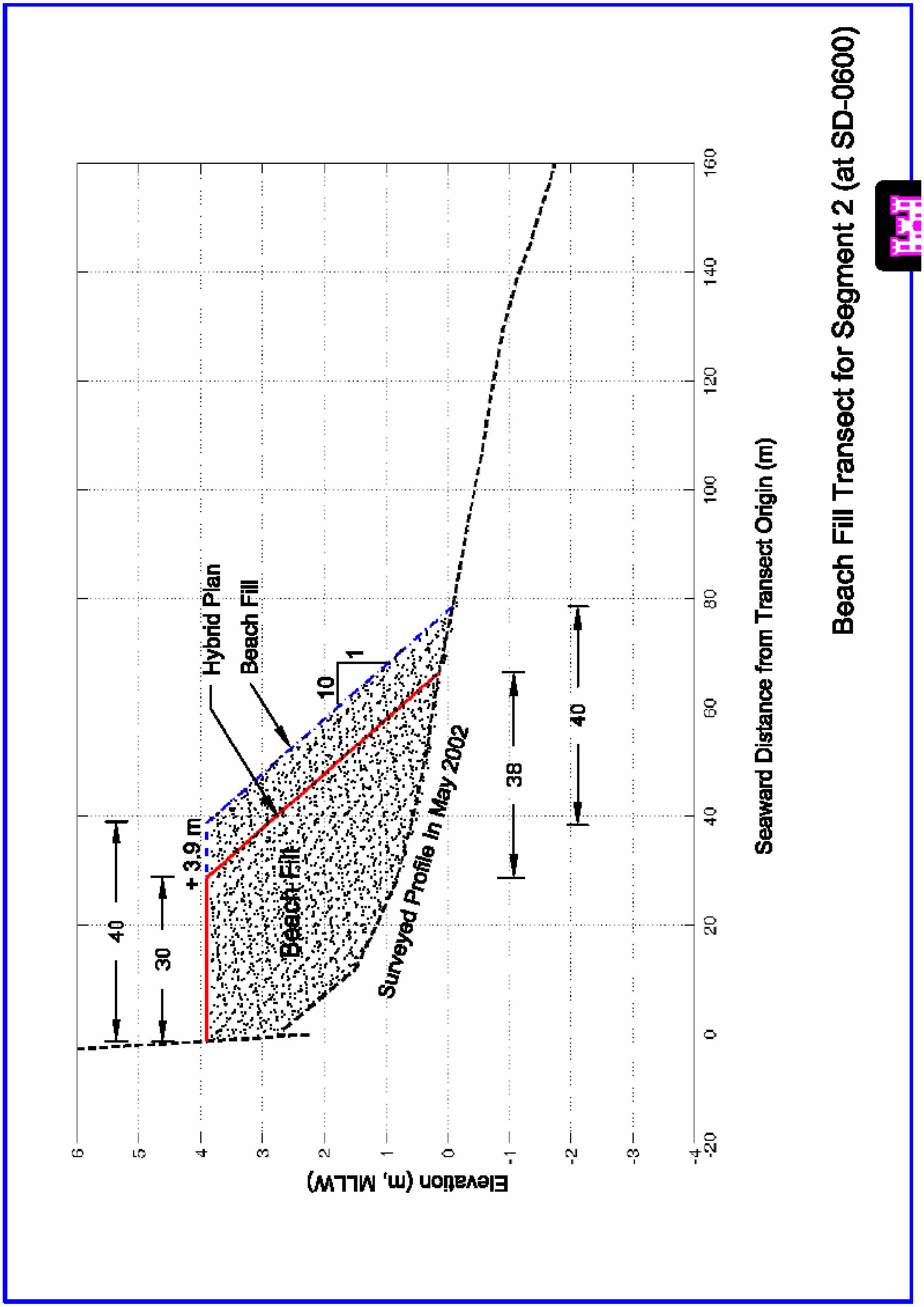


FIGURE 5-4 RECOMMENDED PLAN FOOTPRINT, SEGMENT ONE

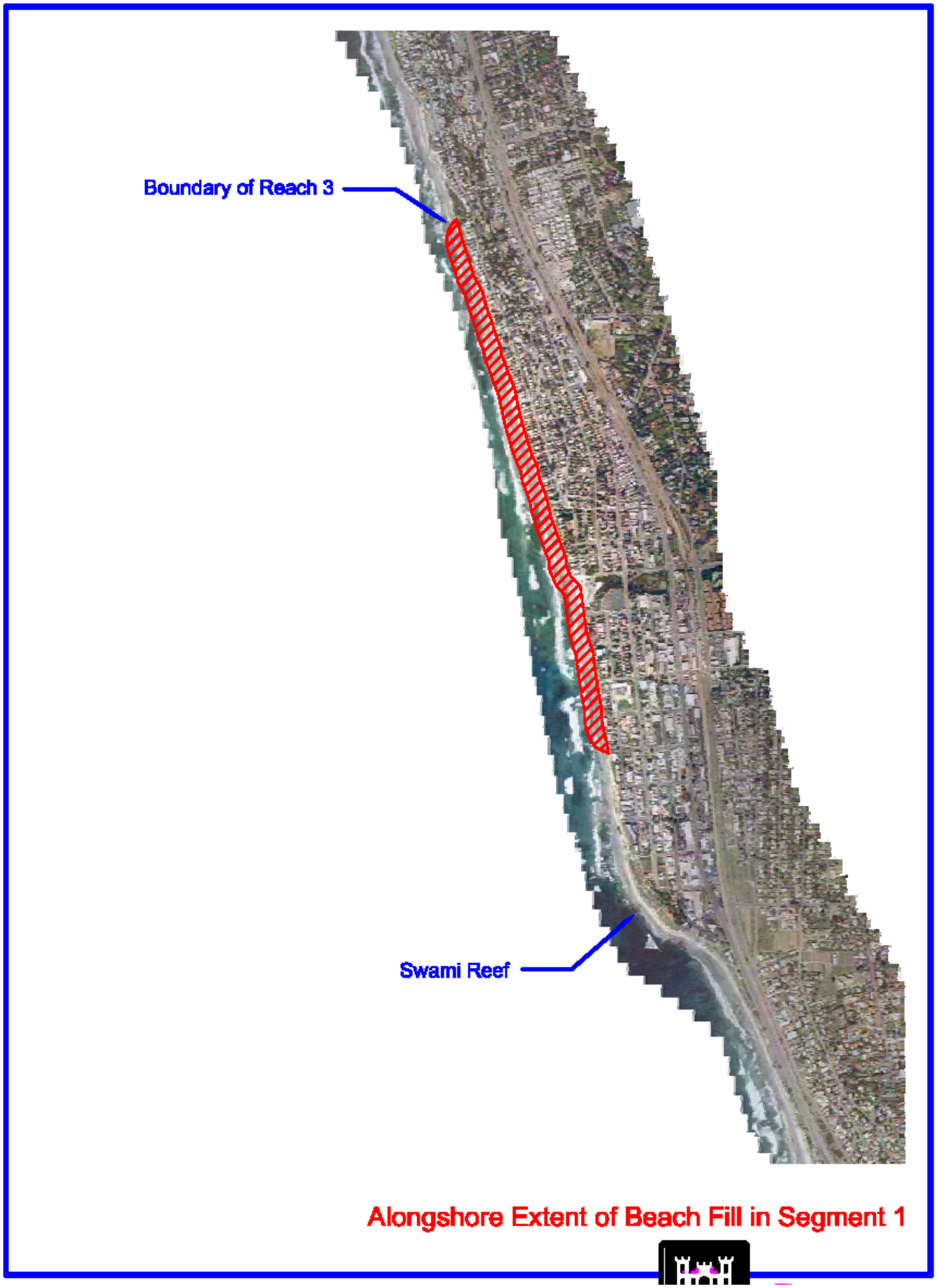


FIGURE 5-5 RECOMMENDED PLAN FOOTPRINT, SEGMENT TWO

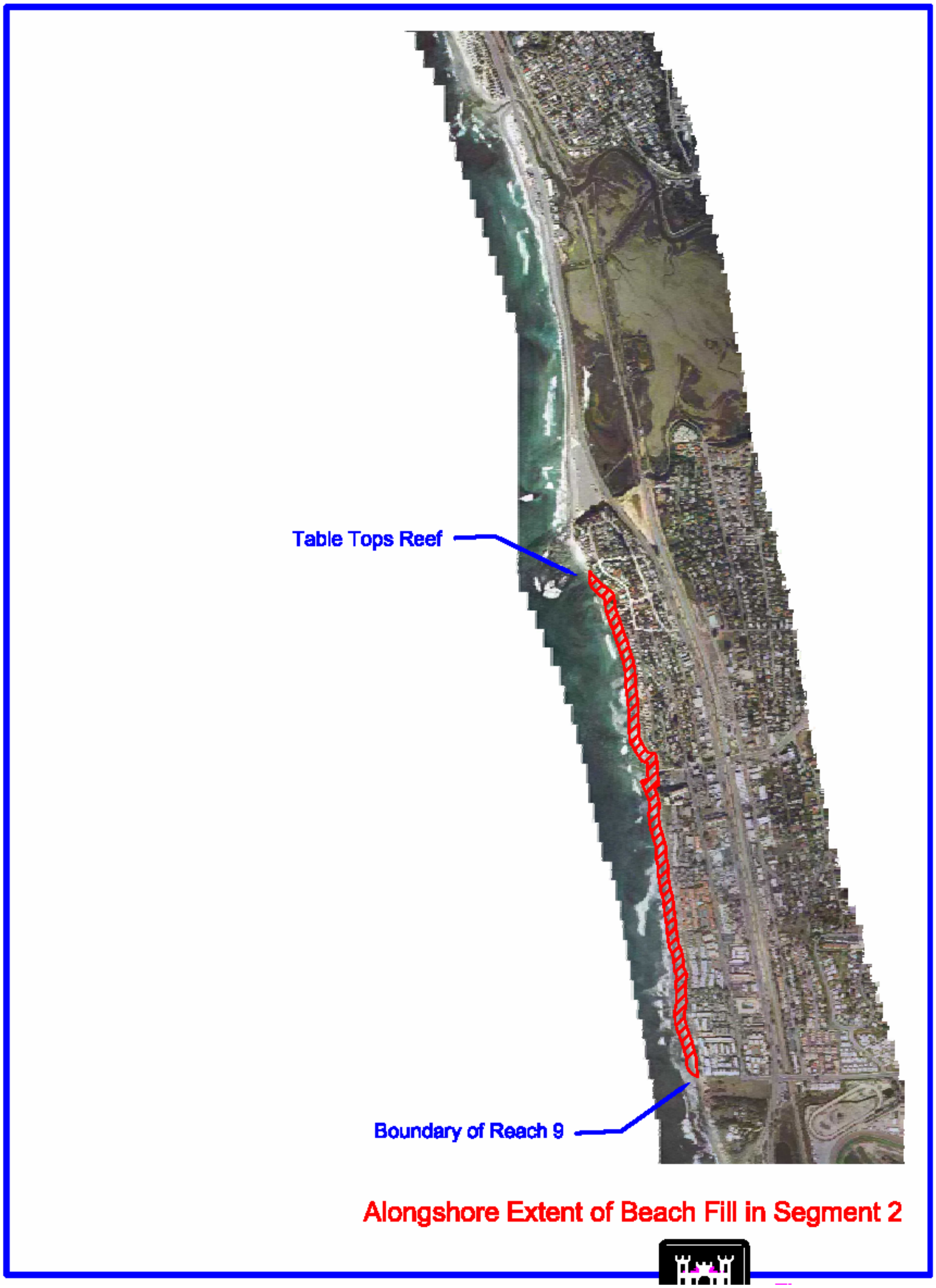


FIGURE 5-6 – PHOTOGRAPH OF TYPICAL NOTCH/SEA CAVE FORMATION

FIGURE 5-7 PHOTOGRAPH OF EXISTING, TYPICAL NOTCH FILL (WITH NO BEACH FILL)

Project Costs

Table 5.1 presents a summary of the project economic costs for the Recommended Plan.

Table 5-1: Recommended Plan Economic Costs

Encinitas/Solana Beach Shoreline Feasibility Study Recommended Plan Economic Costs		
Description	Code of Acct.	Alternative 2-Hybrid
1 Dredging		
Segment 1 Dredge Volume(cu. m)		628,100
Unit Cost		$7.03
Segment 2 Dredge Volume (cu. m)		309,600
Unit Cost		$6.75
Subtotal		$6,505,343
Mob/Demob		$1,430,560
Subtotal Dredge Cost		$7,935,903
2 Notch fill (LM)		
Segment 1 length (m)		2,400
Segment 2 length (m)		2,200
Unit Cost (LM)		$317
Subtotal Notch fill Cost		$1,459,870
Subtotal Dredge + Notch fill		$9,395,773
Contingency 25%		$2,348,943
Total Construction Cost		$11,744,716
PED		$2,000,000
Construction Mgmt (S&A) 7%		$763,407
First Cost Initial Construction		**$14,508,123**
IDC		$138,000
NPV Future Beach Monitoring Cost		$833,385
NPV Future Dredging		$14,297,322
NPV Environmental Monitoring Cost		$365,117
Gross Investment		**$30,142,000**
Subtotal Annual Cost		$1,747,600
Annual O&M		$25,000
Total Annual Cost		**$1,772,600**

Project Benefits

The benefits of the Recommended Plan include avoided private seawall costs, recreational, and environmental benefits. In Segment 1, the project will provide protection for properties along a 2.4 kilometer stretch of shoreline. Along Segment 2, the project will provide protection for properties along a 2.2 kilometer stretch of shoreline. Recreational enefits arise from a wider beach in both areas.

Table 5.2 presents the economic analysis for the Recommended Plan based on a comparison of costs and benefits on an equivalent annual basis. The average annual cost of the project is $1,772,600, and the average annual benefits are $2,582,200. Therefore, the project has a benefit-to-cost ratio of 1.46 to 1, with an average annual net benefit of $809,600.

Table 5-2 - Economic Analysis of the Recommended Plan (Annualized Average Costs and Benefits)

Recommended Plan Economic Analysis			
Reach	**Without Project Damages**	**Recommended Plan Residual Damages**	**Benefits**
Segment 1	$957,304	$219,240	$738,100
Segment 2	$799,487	$246,441	$553,000
Total Damage Benefits			$1,291,100
Recreation Benefits			$1,291,100
		Total Annualized Benefits	$2,582,200
		Total Annualized Costs	$1,772,600
		Benefit-to-Cost Ratio	1.46
		Net Benefit	**$809,600**

5.2.1 General Description of Activities

The construction process would consist of: (1) scraping the sand layer away to expose the bedrock layer at the toe of the bluff; (2) sealing off eroded notches with erodible concrete; and (3) beach replenishment. The sand dredging, transporting, and placement equipment and techniques would be identical to Alternative 1, only the footprint and volumes would be reduced. The construction equipment required for filling notches includes a high-pressured nozzle for concrete fill, trucks, and powered hand tools.

5.2.2 Construction Sequence and Duration

The exact sequence of notch fills and beach fills would be up to the contractor, depending on site conditions, equipment, and access. Beach fill operations would occur on a 24/7 basis, but not at the same site at the same time as notch fill operations.

5.2.3 Notch Fill

During low tide, the area immediately in front of the notch is cleared of sand. The erodible concrete is mixed with a quick dry additive, and a layer of the concrete approximately 15-centimeter (6-inch) thick is sprayed along an area of bluff approximately 30.5 linear meters (100 linear feet). The quick-drying concrete sprayed at the beginning of the area would be dry once the entire area has been sprayed, and an additional 15 centimeters (6 inches) will be sprayed on top of the first layer. This process would be repeated until the notch is filled and matches the face of the surrounding bluff. Approximately 0.76 m^3 (1.0 y^3) of erodible concrete is required per linear meter (3.3 linear feet) of a 1.8-meter (6-foot) deep notch. The total volume of concrete required to fill notches in the bluff base would be determined by the specific site conditions at the time of project construction. However, based on an estimate of approximately 1.0 mile of bluff protection, approximately 4,587 m^3 (6,000 y^3) of concrete will be needed.

At an estimated production rate of 100 feet per day, approximately 46 days would be required to complete the notch fills. However, work can only occur approximately 2 weeks per month due to tides. This would be done concurrently, but not co-located, with beach replenishment.

5.2.4 Beach Replenishment

Sand would be dredged from previously surveyed and mined offshore sites (designated MB-1 and SO-6) and placed directly onto the beach at two receiver sites. Construction specifications will control where the sand is mined and where it is placed, but the dredging contractors bidding on the job will select the exact methods and equipment. The discussion below includes all equipment that could feasibly be selected.

Prior marine geology studies in the project area have identified at least two potential offshore borrow sites (SANDAG, 2001). It is likely that beach fills would be constructed using hopper dredge equipment to import material from identified offshore borrow sites located in the San Diego region. However, it is the contractors option to use a cutterhead dredge, so descriptions of hopper and cutterhead dredging operations are provided below.

Hopper Dredge

The hopper dredge is a self-contained vessel that loads sediment from an offshore borrow site then moves to a receiver site for sand placement. The hopper dredge contains two large arms that have the ability to drag along the ocean floor and collect sediment. The drag heads are about 0.9 m^2 (10 ft^2). The hopper dredge moves along the ocean surface with its arms extended, passing back and forth in the designated borrow site until the hull is fully loaded with sediment. The hopper dredge can generally reach within approximately 0.8 km (0.5 mi) of shore to offload. From this position, the hopper dredge connects to a floating or submerged pump line from shore. The vessel then discharges a mixture of sediment and seawater onto the receiver site. Submerged lines would be sufficiently encased by large tractor tires to prevent abrasion of the ocean floor, reefs, or other seabed habitats. One hopper dredge would be required under Alternative 1.

Cutterhead Dredge

The cutterhead is a floating vessel equipped with a rotating cutter apparatus surrounding the intake end of the suction pipe. This dredge has the capability of pumping dredged material long distances to upland disposal areas, but it can only dredge to a depth of about 75 feet. It is generally only cost effective for sources within approximately 16,000 feet of the receiver site, which means it would only be considered for dredging at SO-6. The cutterhead dredge is usually equipped with two stern spud anchors used to hold the dredge in working position and to advance the dredge into the cut or excavating area. During operation, the cutterhead dredge swings from side to side alternately using the port and starboard spuds as a pivot. Cables attached to anchors on each side of the dredge control lateral movement. Forward movement is achieved by lowering the starboard spud after the port swing is made and then raising the port spud. The dredge is then swung back to the starboard side of the cut centerline. The port spud is lowered and the starboard spud lifted to advance the dredge. Floating pipeline is then connected from the barge to the beach.
One cutterhead dredge would be required if it is the selected equipment, with one anchor tender vessel to move the spuds when required.

Monobuoy w/ Hopper

The hopper dredge requires a monobuoy to discharge its sand onto the beach. A mono buoy is a floating pipeline connection platform that is moored to the seafloor, and is used to interconnect with a steel sinker pipeline that carries the slurry along the seafloor to the beach. The mono buoy is generally anchored to the seabed at an appropriate depth and location to serve the project needs, depending on locations of sensitive resources and engineering considerations. For this project the mono buoy would be anchored in at least 7.6 meters (25 feet) of water, between 2,500 and 5,000 feet from shore. From one monobuoy location, sand can be pumped directly onshore and up to approximately 2,000 feet alongshore in either direction. Once this 4,000 foot (maximum) stretch of beach has been filled, the monobuoy is picked up and moved to the next fill zone.

Booster Pump w/ Cutterhead
For the cutterhead pipeline discharge, the pipe would be laid on the seafloor from SO-6 straight into shore, landing at Cardiff Beach. A booster pump would be required to pump the slurry up or down coast from that point. The beach pipeline would be partially buried so it would not impede public access or present a hazard on the beach (except at the point of discharge)

Onshore Placement

For both the hopper and cutterhead methods, sand is combined with seawater until it reaches the consistency of slurry. It is then conveyed to the beach either via pipeline or a combination of hopper dredge and pipeline, as described above.

Existing sand at each receiver site is used to build a small, "L"-shaped berm to anchor the sand placement operations. The short side of the "L" is transverse to the shoreline and is approximately the same width as the design beach for each segment. The long side is shore parallel, at the seaward edge of the design beach footprint. The long side is initially approximately 200 feet long.

When slurry is pumped onto the beach, it is pumped between this berm and the bluff toe. This berm reduces ocean water turbidity by allowing all the sand to settle out inside the bermed area while the seawater is channeled just inside the long berm until it reaches the open end where it drains across the shore platform and into the ocean. Temporary dikes within this berm will direct the pumped sand for settlement in designated areas. Once a 200 foot section of berm is filled in with sand, another 200 feet of berm is created, the pipeline is moved or extended into the new berm area, and the process begins again

As the material is deposited behind the berm, the sand would be spread using two bulldozers and one front-end loader to direct the flow of the sand slurry and form a gradual slope to the existing beach elevation. A crew of up to 10 people will be required for the beach work. The construction sequence is described in further detail below.

For each receiver site, berm construction may be adjusted from the design requirements during fill placement depending on actual field conditions. The measurements indicated for the width of the berms are the initial placement widths. The berms would be subject to the forces of the waves and weather once constructed, and will eventually settle down to a natural grade for the beach.

Construction Access and Staging Areas

Beach access for the construction equipment and crew in Segment 1 will be at Moonlight Beach. Beach access for the construction equipment and crew in Segment 2 will be at Fletcher Cove. Since the work would not be done during winter storms, and because the construction equipment would be used on a 24/7 basis, there would be only occasional need for a staging area. Should equipment need to be temporarily moved off the beach, it will be stored in parking lots at the access points. Any fueling or maintenance activities would occur at the staging areas, and the contractor would be required to prepare a plan for hazardous spill containment. Public parking areas are available for use by the construction crew. The dredge crew would park at the port of operations for the dredge, and the shore crew of approximately 10 people and a notch crew of 5 people would park in available public parking lots near the beach access points.

Public Access

Public access will be restricted for a radius of approximately 150 feet around the notch fill operations. This zone will move approximately 100 ft. per day so no single location will be impacted more than a few days. For the beach fill operation, the only impacts to public beach access would occur at the point of discharge. Approximately 300 feet of beach would be inaccessible to the public around the discharge pipeline and berms. In addition, there would be intermittent restrictions on public access for approximately 350 feet on either side of this discharge zone. This space would be needed for maneuvering heavy equipment during construction of the temporary berms.

5.2.5 Future Project Beach Profile Monitoring

Project performance monitoring in support of continuing construction will include bathymetric and topographic surveys every three years, together with a nearly continuous record of the beach topography obtained from the video-based stereo photogrammetric Argus Beach Measurement System. The monitoring period will be for the 50-year period of Federal involvement. The main purpose of project performance monitoring is to allow better planning of continuing construction (periodic renourishment), both in terms of the timing of the renourishment and details of the beach fill construction.

5.3 ENVIRONMENTAL EFFECTS OF RECOMMENDED PLAN

Effects Found Not to Be Significant
Issues that were brought forward for the proposed Encinitas and Solana Beach Shoreline Protection Project for further analysis and included in the accompanying Draft EIS/EIR included topography, geology and geography, oceanographic and coastal processes, water and sediment quality, biological resources, cultural resources, noise, socioeconomics, transportation, land use, recreation, public safety, and public utilities. This analysis determined that the proposed project would not have a long-term significant effect on these elements.

Significant Unavoidable Adverse Effects
The EIS/EIR considered the potential impacts of the three proposed alternatives, in addition to the No Action Alternative, according to several resource categories: topography, geology and geography, oceanographic and coastal processes, water and sediment quality, biological resources, cultural resources, aesthetics, air quality, noise, socioeconomics, transportation, land use, recreation, public safety, and public utilities. Significant impacts have been identified for impacts to air quality under Alternatives 1 and 2 and aesthetics under Alternative 3.

Environmental Commitments
Table ES-3 shows the environmental commitments to be undertaken by the Corps to ensure environmental impacts are reduced to a level of insignificance where possible.

Table 5-4.
Summary of design features/monitoring commitments and mitigation measures **(if necessary).**

	Purpose	Timing	Implementation Responsibility
Design Features			
Topography, Geology, and Geography: Use of erodible concrete for notch fill material	Mimic natural erosive processes	During notch fill	Construction contractor
Oceanographic Characteristics and Coastal Processes: Use of erodible concrete for notch fill material	Mimic natural erosive processes	During notch fill	Construction contractor
Water and sediment quality: Construct "L"-shaped berms at all receiver sites	Anchor sand placement operations and reduce nearshore turbidity	During beach fill	Construction contractor
Water and sediment quality: Maintenance for land-based vehicles will occur in staging area away from beach and sensitive areas	Avoid minimal contamination from leaks, if any	During beach nourishment/notch fill	Construction contractor
Water and sediment Quality: Use proper BMPs during vehicle fueling	Avoid petroleum spills	During beach nourishment/notch fill	Construction contractor
Water and sediment quality: Generate plan for hazardous spill prevention and containment	Ensure minimal contamination from fuel leaks, if any	During operation of equipment on the beach or in the water	Construction contractor
Biological Resources: Design borrow sites to maintain adequate distance from artificial reefs, kelp, and other features	Avoid direct impacts to artificial reefs and kelp	Final engineering and during construction	Engineering contractor and construction contractor
Biology: Construct second transverse berm to	Section of beach with	If grunion spawning or	Construction

Table 5-4.
Summary of design features/monitoring commitments and mitigation measures **(if necessary).**

	Purpose	Timing	Implementation Responsibility
begin a new cell if grunion spawning or eggs are encountered during construction	grunion would be avoided and bypassed	eggs are encountered	contractor, in coordination with USACE
Biology: No construction shall be performed within 430 m of any sensitive bird species that have clear line of site to the construction area during breeding and nesting season; no beach construction within 215 m of any sensitive bird species during the breeding and nesting season	Minimize impacts to sensitive wildlife of noise emissions	During beach nourishment/notch fill	Construction contractor
Air quality: Use of BMPs to reduce air quality impacts such as the use of BACT and/or BART for the dredge	To reduce air emissions	During all construction activities	Construction contractor
Air quality: Construction equipment will be properly maintained and tuned	To reduce air emissions	During beach nourishment/notch fill	Construction contractor
Noise: Construction equipment shall be fitted with mufflers, air intake silencers, and engine shrouds; stationary noise sources will be located far from residential receptor locations	Minimize noise emissions	During beach nourishment/notch fill	Construction contractor
Noise: A noise variance shall be obtained for work done after 7 pm from the City of Encinitas and the City of Solana Beach	Public notification and approval	Prior to the commencement of any work	Construction contractor
Noise: In Reach 8, no beach construction shall be performed within 430 m (1,400 ft) of any sensitive bird species that have a clear line of sight to the construction area during the breeding and nesting season; and no beach construction shall be performed within 240 m (790 ft) of any sensitive bird species during the breeding and nesting season	Minimize impacts to sensitive wildlife of noise emissions	During beach nourishment/notch fill	Construction contractor
Recreation: Communicate with local jurisdictions to avoid recreational events	Avoid disruption of established recreational events	During beach nourishment/notch fill	Construction contractor
Public safety: Avoid placing fill material near storm drain outlets	Continue proper drainage	During beach nourishment/notch fill activities	Construction contractor, in coordination with City Engineer
Public safety: Generate plan for hazardous spill prevention and containment	Ensure minimal contamination from fuel leaks, if any	During operation of equipment on the beach or in the water	Construction contractor
Public Safety: Issue Notice to Mariners and maintain 500-foot buffer around active dredge equipment	Warn boaters/fishermen of dredging activities to ensure avoidance	Before and during dredging activities	Coast Guard (via construction contractor)
Public Safety: Generate safety plan to restrict public access at receiver and notch fill sites and maintain 45-m (150-foot) buffer around construction areas	Public safety during construction	During beach nourishment/notch fill activities	Construction contractor, in coordination with local lifeguards
Public Safety: Relocation of temporary lifeguard towers	Public safety during construction	During beach nourishment activities/notch fill	Construction contractor, in coordination with local lifeguards
Public Safety: Sand placement to avoid blocking line-of-sight at permanent lifeguard towers	Public safety during construction	During beach nourishment activities	Construction contractor, in coordination with local lifeguards
Socioeconomics: Coordination with commercial fishermen; establishment of offshore transit corridors in consultation with a commercial fishermen representative; issue Notice to Mariners	Avoid gear conflicts and provide for compensation if loss occurs	Before and during dredging operations	Coast Guard (via construction contractor) and USACE
Monitoring Commitments			
Water and Sediment Quality: Monitor turbidity levels	To avoid turbidity impacts to fish and aquatic species	During dredging operations and beach fill activities	

Table 5-4.
Summary of design features/monitoring commitments and mitigation measures **(if necessary).**

	Purpose	Timing	Implementation Responsibility
Biology: Conduct nearshore underwater surveys	Establish baseline data for comparison purposes and determine if any natural/ biological resources/habitats have been adversely impacted by the project	Prior to construction and after construction	Qualified biologist
Biology: Monitor weekly for grunion spawning in construction area, establish buffer extending 30 m shoreward of high tide line and 30 m upcoast and downcoast (total 200 feet), until eggs hatch (minimum of one lunar month) and surveys show no subsequent spawning	Avoid grunion eggs and protect until hatched	April through September and per CDFG annual pamphlet *Expected Grunion Runs*.	Qualified biologist
Public Safety: Generate safety plan to restrict public access at receiver and notch fill sites and maintain 45-m (150-foot) buffer around construction areas	Public safety during construction	During beach nourishment/notch fill activities	Construction contractor, in coordination with local lifeguards
Post-Project Mitigation Measures (If Necessary)			
Biology: Restoration or creation of like habitat at a ratio to be determined with the responsible resource agencies according to the long-term significant impacts, if any, to marine resources	Mitigate for significant, long-term Impacts, if any, to sensitive marine resources caused by sediment placement or transport	Subsequent to resource agency review of monitoring reports and determination that significant impact had occurred	Qualified biologist

Chapter 6. Implementation of Recommended Plan

6.1 General

This chapter presents the Federal and non-Federal responsibilities for implementing the Recommended Plan. This includes Federal and non-Federal project cost sharing requirements and the division of responsibilities between the Federal government and the Non-Federal Sponsors, the City of Solana Beach and the City of Encinitas. It also lists the steps toward project approval, and a schedule of the major milestones for the design and construction of the Recommended Plan.

6.2 Cost Apportionment for the Recommended Plan

Cost sharing for initial construction of the NED plan would be consistent with that specified in Section 103(c)(5) of WRDA 86 as amended by WRDA 96 (generally 65 percent Federal and 35 percent non-Federal). Cost sharing for periodic nourishment (continuing construction) would be consistent with Section 103(d) of WRDA 86 as amended by Section 215 of WRDA 99, which requires that such costs be shared 50 percent Federal and 50 percent non-Federal.

These general cost shares apply for developed public or private shores where there is adequate public access and use. For public non-Federal shores, such as a park, the cost sharing for initial construction and each renourishment is 50/50 and for private non-developed shores the cost sharing is 100 percent non-Federal. Federal shores are cost shared 100 percent Federal.

The study area consists mostly of developed public or private shores and will be therefore subject to the general cost sharing of 65% Federal, 35% non-Federal for the initial project and 50/50 for each renourishment. From the list of parks in Section 2.9.5, the only parks that exist within the two Segments that provide recreational facilities are Moonlight Beach (Segment 1) and Fletcher Cove (Segment 2). The portion of the project that protects these areas will be subject to 50% Federal, 50% non-Federal initial and renourishment cost sharing.

Seven privately owned vacant lots currently exist in the Segments 1 and 2. The portion of the Federal project that would protect privately owned vacant lots would be cost shared 100% non-Federal. It is assumed that these lots will be developed prior to project construction. Therefore, cost sharing for the portion of the project protecting these areas will be subject to the general cost sharing. If, upon execution of a Project Construction Agreement (PCA), these lands are still undeveloped, project cost sharing will be modified to reflect 100% non-Federal cost sharing for those portions. **Table 6-1** displays the study area land use in terms of shoreline length.

Table 6-1: Study Area Land Use

Land Type	Length
Developed public or private shores	5,170 m
Public park	330 m
Total Project Length	5,500 m

Tables 6-2 and **6-3**, below, display the currently assumed Federal cost sharing for initial construction and each renourishment respectively.

Table 6-2: Federal Cost Share: Initial Construction

Land Type	Fraction	Percent Federal Share	Weighted Federal Share
Developed public or private shores	.94	0.65	0.61
Public park	.06	0.5	0.03
Total Federal cost share initial construction			**0.64**

Table 6-3: Federal Cost Share: Renourishment

Land Type	Fraction	Percent Federal Share	Weighted Federal Share
Developed public or private shores	.94	0.5	0.47
Public park	.06	0.5	0.03
Total Federal cost share renourishment			**0.50**

Based on these calculations, cost sharing for the project will be as follows:

- Initial construction costs, including sunk costs, are cost shared at 64% Federal and 36% non-Federal.
- Costs for project performance monitoring in support of continuing construction, used to refine plans for the beach renourishment, are cost shared at 50% Federal and 50% non-Federal.
- Total beach renourishment costs are cost shared at 50% Federal and 50% non-Federal.

Table 6-4 indicates that the project first costs are $14,537,500, of which non-Federal costs total $5,233,500 and Federal costs total $9,304,000.

Table 6-4: Federal and Non-Federal Initial Costs of the Recommended Plan

		Non-Federal		Federal	
	Total Cost	**%**	**Cost**	**%**	**Cost**
Cash	**$14,508,000**		**$5,204,000**	**64**	**$9,304,000**
Real Estate (LERRD's)	**$29,500**		**$29,500**		**-**
Cost Share: First Costs	**$14,537,500**	**36**	**$5,233,500**	**64**	**$9,304,000**

Table 6-5 presents the Federal and non-Federal apportionment of the Net Present Value (NPV) and Average Annual Value of future periodic costs (renourishment and project monitoring to refine renourishment plans) for the Recommended Plan. This Table indicates that the net present value of

future project costs for renourishment and for performance monitoring in support of continuing construction (renourishment) is $14,933,000, of which $7,466,500 is Federal and $7,466,500 is non-Federal.

Table 6-5: Federal and Non-Federal Future Costs of the Recommended Plan

		Non-Federal		Federal	
	Total Cost	**%**	**Cost**	**%**	**Cost**
Performance Monitoring Costs (NPV)	**$833,000**	50%	**$416,500**	50%	**$416,500**
Environmental Monitoring Costs (NPV)	**$365,000**	50%	**$182,500**		**$182,500**
Renourishment Costs (NPV)	**$13,735,000**	50%	**$6,867,500**	50%	**$6,867,500**
Cost Share: Continuing Construction (NPV)	**$14,933,000**	50%	**$7,466,500**	50%	**$7,466,500**
Average Annual Cost: Continuing Construction	**$865,600**	50%	**$423,800**	50%	**$423,800**

Finally, **Table 6-6** illustrates the cost apportionment for the total project, at October 2004 price levels. It shows that the ultimate project cost is $59,879,500 of which $27,904,500 (46.6%) is non-Federal and $31,975,000 (53.4%) is Federal.

Table 6-6: Federal and Non-Federal Cost Apportionment for the Total Project

Item	**Total Project Cost**	**Non-Federal Cost**	**Federal Cost**
Initial Construction			
Cash	**$14,508,000**	**$5,204,000**	**$9,304,000**
Non-Federal LERRD's	**$29,500**	**$29,500**	**-**
Total Initial Cost	**$14,537,500**	**$5,233,500**	**$9,304,000**
Total Continuing Construction Cost (not discounted)	**$45,342,000**	**$22,671,000**	**$22,671,000**
Ultimate Project Cost	**$59,879,500**	**$27,904,500**	**$31,975,000**
Percentage Share		**46.6%**	**53.4%**

6.3 Division of Plan Responsibilities

The Federal Government and the Cities of Solana Beach and Encinitas are responsible for implementation of the Recommended Plan, including the sharing of costs and maintenance. In addition, certain responsibilities are required by each party in accordance with Federal law. Since the project consists of two separable segments; one located entirely within the City of Encinitas and the other located entirely within the City of Solana Beach, it is assumed that each non-Federal sponsor will provide monetary contributions in proportion with the costs associated with construction and maintenance of the project within its jurisdiction.

6.3.1 Federal Responsibilities

Responsibilities of the Federal Government for implementation of the Recommended Plan include:

a) Sharing a percentage of the costs for Planning, Engineering and Design (PED), including preparation of the Plans and Specifications, which is cost shared at the same percentage that applies to construction of the project.

b) Sharing a percentage of construction costs for the project. See **Table 6-3** and **Table 6-4.**
c) Administering contracts for construction and supervision of the project after authorization funding, and receipt of non-Federal assurances.

6.3.2 Non-Federal Responsibilities

Federal law requires that a local non-Federal sponsor provide and guarantee certain local cooperation items to ensure equitable participation in a project and to ensure continual maintenance and public receipt of the intended benefits. The particulars of the Recommended Plan were carefully reviewed and a set of applicable local cooperation items established to include cost sharing of the Project as prescribed in the above paragraphs. The local non-Federal sponsors will:

a. Provide 35 percent of initial project costs assigned to hurricane and storm damage reduction, plus 50 percent of initial project costs assigned to protecting public park lands, plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits; and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction, plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits (See **Table 6-3** and **Table 6-4**) and as further specified below:
   (1) Enter into an agreement that provides, prior to construction, 25 percent of design costs;
   (2) Provide, during construction, any additional funds needed to cover the non-federal share of design costs;
   (3) Provide all lands, easements, and rights-of-way, and perform or ensure the performance of any relocations determined by the Federal Government to be necessary for the initial construction, periodic nourishment, operation, and maintenance of the project;
   (4) Provide, during construction, any additional amounts as are necessary to make their total contribution equal to 35 percent of initial project costs assigned to hurricane and storm damage reduction, plus 50 percent of initial project costs assigned to protecting public park lands, plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits; and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction, plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;
   (5) Not be jointly and severally liable for fulfilling the non-Federal responsibilities, such as the non-Federal monetary contributions. The reason for this is that the project consists of two separable segments, each located in an adjacent city, where the benefits attributed to each segment outweigh the cost of each segment. While each segment could be constructed separately, this is justified as a single project in that significant cost savings relating to the reduction in mobilization/de-mobilization costs are achieved constructing the two segments together. And, the project will be constructed entirely on State lands.
b. For so long as the project remains authorized, operate, maintain, and repair the completed project, or functional portion of the project, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;
c. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the Non-Federal Sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating, or completing the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall relieve the Non-Federal Sponsor of responsibility to meet the Non-Federal Sponsor's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;
d. Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors;
e. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project in accordance with the standards for financial management systems

set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

f. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the initial construction, periodic nourishment, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the Non-Federal Sponsor with prior specific written direction, in which case the Non-Federal Sponsor shall perform such investigations in accordance with such written direction;
g. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, periodic nourishment, operation, or maintenance of the project;
h. Agree that the Non-Federal Sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, and repair the project in a manner that will not cause liability to arise under CERCLA;
i. If applicable, comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for the initial construction, periodic nourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;
j. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), requiring non-Federal preparation and implementation of floodplain management plans; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)).";
k. Provide the non-Federal share of that portion of the costs of data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the agreement;
l. Participate in and comply with applicable Federal floodplain management and flood insurance programs;
m. Do not use Federal funds to meet the non-Federal sponsor’s share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.
n. Prescribe and enforce regulations to prevent obstruction of or encroachment on the project that would reduce the level of protection it affords or that would hinder future periodic nourishment and/or the operation and maintenance of the project;
o. Not less than once each year, inform affected interests of the extent of protection afforded by the project;
p. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain, and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

q. For so long as the project remains authorized, the Non-Federal Sponsor shall ensure continued conditions of public ownership and use of the shore upon which the amount of Federal participation is based;
r. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;
s. Recognize and support the requirements of Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element; and
t. At least twice annually and after storm events, perform surveillance of the beach to determine losses of nourishment material from the project design section and provide the results of such surveillance to the Corps of Engineers.

6.4 Local Sponsor Financial Capability

Local funds for this project will be provided by the City of Encinitas, the City of Solana Beach, and the State of California, through the California Department of Boating and Waterways. The California Department of Boating and Waterways' Beach Nourishment Program is funded through annual appropriations. Under that Program the State will fund 85% of the local share and Cities will be required to contribute 15% of the local share.

6.5 Project Cooperation Agreement

Prior to advertisement for the Construction Contract, a Project Cooperation Agreement will be required to be signed by the Federal Government and the Cities of Encinitas and Solana Beach committing each party to the responsibilities for implementing and maintaining the project. This agreement will be prepared and negotiated during the Plans and Specifications Phase.

6.6 Approval and Implementation

The necessary reviews and activities leading to approval and implementation of the Recommended Plan are listed below:

a. Environmental Impact Statement Filing- The FEIS will be circulated to State and Federal Agencies as directed by HQUSACE for the 30-Day State and Agency review. The District will concurrently distribute the FEIS to parties not included on the HQUSACE mailing list. The District will then file the decision document and FEIS together with the proposed report of the Chief of Engineers with EPA.
b. Chief of Engineers Approval- Chief of Engineer signs the report signifying approval of the project recommendation and submits the following to ASA (CW): the Chief of Engineers Report, the FEIS, and the unsigned ROD.
c. ASA (CW) Approval- The Assist. Secretary of the Army for Civil Works will review the documents to determine the level of administration support for the Chief of Engineers recommendation. The ASA (CW) will formally submit the report to the Office of Management and Budget (OMB) OMB will review the recommendation to determine its relationship to the program of the President. OMB will approve the release of the report to Congress.
d. Funds could be provided, when appropriated in the budget, for preconstruction, engineering and design (PED), upon issuance of the Division Commander's public notice announcing the completion of the final report and pending project authorization for construction.
e. Surveys, model studies, and detailed engineering and design for PED studies will be accomplished first and then plans and specifications will be completed, upon receipt of funds.
f. Prior to advertisement for the construction contract, formal assurances of local cooperation in the form of a Local Cooperation Agreement will be required from non-Federal interests (the Local Sponsor).

Construction would be initiated with Federal and non-Federal contributed funds, once the construction project was advertised and awarded.

CHAPTER 7.0 PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

7.1 Coordination and Public Views

Public workshops, scoping meetings, and coordination with Federal, State, and local agencies have been accomplished to aid in the formulation and evaluation of the proposed Recommended Plan. The draft Feasibility Report, EIS/EIR will be coordinated with representatives from EPA, US Fish and Wildlife Service, National Marine Fisheries, California State Fish and Game, and the City of Imperial Beach.

7.2 PUBLIC INVOLVEMENT

Numerous public workshops were held both during the reconnaissance and feasibility phases of the study. Below is a summary of public hearings at which the study objectives and results to date were shared and the public had an opportunity to get comments on the record and ask the study team questions.

- Reconnaissance Workshop, 26 Jun, 1995

- F2 Public Workshop, Encinitas City Hall, Oct. 23, 2001

- City Council Meeting, Solana Beach, July 24 2003

- City Council Meeting, Solana Beach, Oct . 11 2003

- Public Workshop, Encinitas City Hall, July 22, 2004

There is a great deal of public interest in shoreline issues in the study area. Public meetings addressing these issues are always well attended. Although nearly everyone supports beach replenishment, opinion seems to be generally polarized by the issue of coastal structures, whether toe protection or offshore structures. Local citizens have formed groups to advocate their views on this issue before policy makers and public officials. Below is a summary of the main points of the debate.

Those who oppose coastal “hard” structures feel that in general, they;

1. are dangerous and ineffective

2. are ugly and ruin the view of the coastline

3. accelerate beach erosion

4. degrade surfing conditions

5. encroach on public beach and swimming areas

Those who support coastal structures feel that, if properly designed, they:

1. safely and effectively reduce/prevent property damage

2. can be built small and aesthetically pleasing

3. do not accelerate beach erosion

4. do not necessrily degrade surfing conditions

5. do not encroach on public beach

More workshops are now being scheduled to present and discuss the alternative plans and solicit further input. Public input will be carefully weighed in the Final recommendations.

7.3 INSTITUTIONAL INVOLVEMENT

7.4 ADDITIONAL REQUIRED COORDINATION

7.5 REPORT RECIPIENTS

7.6 PUBLIC VIEWS AND RESPONSES

The documentation of public views and responses was extensive enough to justify a separate Appendix. Please see **Appendix A, Public Involvement.**

8.0 RECOMMENDATIONS

I recommend that the selected plan for storm damage protection along the shoreline within the corporate boundaries of the Cities of Encinitas and Solana Beach as described in this report be authorized as a Federal project, with such modifications as in the discretion of the Chief of Engineers may be advisable. The recommended plan is estimated to have an initial total cost of $14,537,500 (October 2004 price levels). Of this cost, 64% or $9,304,000 will be the responsibility of the Federal government and 36% or $5,233,500 will be the responsibility of the Cities of Encinitas and Solana Beach.

The recommended plan further includes periodic nourishment at five year intervals within the 50-year project lifetime for a total of nine periodic renourishment episodes, project beach monitoring for periodic nourishment planning, and environmental monitoring. The recommended plan is estimated to have an average annual cost for continuing construction of $865,600 over the 50-year project lifetime. Of this cost, 50% or $423,800 will be the responsibility of the Federal government and 50% or $423,800 will be the responsibility of the Cities of Encinitas and Solana Beach.

This recommendation is made with the provision that before implementation, the Cities of Encinitas and Solana Beach will, in addition to the general requirements of law for this type of project, agree to the following requirements:

a. Provide 35 percent of initial project costs assigned to hurricane and storm damage reduction, plus 50 percent of initial project costs assigned to protecting public park lands, plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits; and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction, plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits (See **Table 6-3** and **Table 6-4**) and as further specified below:
   (1) Enter into an agreement that provides, prior to construction, 25 percent of design costs;
   (2) Provide, during construction, any additional funds needed to cover the non-federal share of design costs;
   (3) Provide all lands, easements, and rights-of-way, and perform or ensure the performance of any relocations determined by the Federal Government to be necessary for the initial construction, periodic nourishment, operation, and maintenance of the project;
   (4) Provide, during construction, any additional amounts as are necessary to make their total contribution equal to 35 percent of initial project costs assigned to hurricane and storm damage reduction, plus 50 percent of initial project costs assigned to protecting public park lands, plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits; and 50 percent of periodic nourishment costs assigned to hurricane and storm damage reduction, plus 100 percent of periodic nourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;
   (5) Not be jointly and severally liable for fulfilling the non-Federal responsibilities, such as the non-Federal monetary contributions. The reason for this is that the project consists of two separable segments, each located in an adjacent city, where the benefits attributed to each segment outweigh the cost of each segment. While each segment could be constructed separately, this is justified as a single project in that significant cost savings relating to the reduction in mobilization/de-mobilization costs are achieved constructing the two segments together. And, the project will be constructed entirely on State lands.

b. For so long as the project remains authorized, operate, maintain, and repair the completed project, or functional portion of the project, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

c. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the Non-Federal Sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating, or completing the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall relieve the Non-Federal Sponsor of responsibility to meet the Non-Federal Sponsor's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;

d. Hold and save the United States free from all damages arising from the initial construction, periodic nourishment, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors;

e. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

f. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the initial construction, periodic nourishment, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the Non-Federal Sponsor with prior specific written direction, in which case the Non-Federal Sponsor shall perform such investigations in accordance with such written direction;

g. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, periodic nourishment, operation, or maintenance of the project;

h. Agree that the Non-Federal Sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, and repair the project in a manner that will not cause liability to arise under CERCLA;

i. If applicable, comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for the initial construction, periodic nourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

j. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), requiring non-Federal preparation and implementation of floodplain management plans; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)).";

k. Provide the non-Federal share of that portion of the costs of data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the agreement;

l. Participate in and comply with applicable Federal floodplain management and flood insurance programs;

m. Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

n. Prescribe and enforce regulations to prevent obstruction of or encroachment on the project that would reduce the level of protection it affords or that would hinder future periodic nourishment and/or the operation and maintenance of the project;

o. Not less than once each year, inform affected interests of the extent of protection afforded by the project;

p. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain, and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

q. For so long as the project remains authorized, the Non-Federal Sponsor shall ensure continued conditions of public ownership and use of the shore upon which the amount of Federal participation is based;

r. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;

s. Recognize and support the requirements of Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element; and

t. At least twice annually and after storm events, perform surveillance of the beach to determine losses of nourishment material from the project design section and provide the results of such surveillance to the Federal Government.

These recommendations reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher levels within the Executive Branch. Consequently, the recommendations may be modified before they are sent to the Congress as a proposal for authorization and/or implementation funding. However, prior to transmittal to Congress, the Non-Federal Sponsor, State agencies, Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Alex Dornstauder
Colonel, Corps of Engineers
District Engineer